SIGNALS

JURNAL OF THE ARMY SIGNAL ASSOCIATION • DEDICATED TO MILITARY PREPAREDNESS

THIS ISSUE:

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A.F. TRAINING AT
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NOVEMBER-
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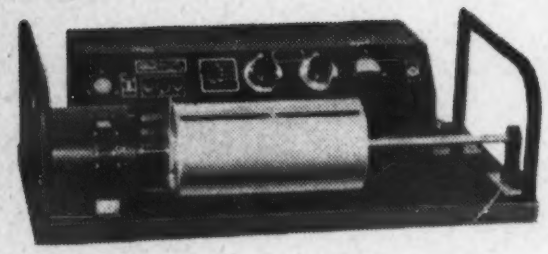

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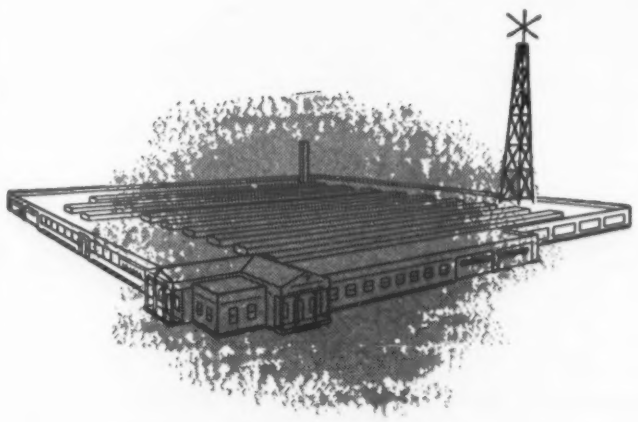

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WASHINGTON

4 NOV 1946

THE ARMY SIGNAL ASSOCIATION:

As Commanding General of the Army Air Forces, I wish to express warm personal greetings to your association. Many of your members were either directly or indirectly associated with the Army Air Forces in World War II.

With the change in warfare brought about by the extensive use of the airplane and the inception of guided missiles, communications and all that the term includes assume an even greater importance. Instead of months or even years spent in preparation for certain operations, days or even hours will be the maximum time allowable in the future. As a result, communications must of necessity be capable of almost instantaneous installation, have round-the-clock dependability, and have a tremendous carrying capacity. It is thus necessary that the newly formed Army Signal Association continually recognize the tremendous responsibilities communications will have and aid in our preparedness by continuing to foster in every way possible the United States' ability to establish and maintain modern high-speed communications second to none.

On this occasion, I also wish to express through you the thanks of the Army Air Forces for the magnificent accomplishments of all communications personnel, both military and civilian, in the late war, and call upon the Army Signal Association to help maintain the same high standards of duty, loyalty and technical fitness in the future.

Carl Spaatz

CARL SPAATZ
General, U. S. Army
Commanding General, Army Air Forces

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SIGNALS

Journal of the Army Signal Association—Dedicated to Military Preparedness

VOLUME 1 NOVEMBER-DECEMBER, 1946 NUMBER 2

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SIGNALS is published bi-monthly by the Army Signal Association at 804-17th St., N.W., Washington 6, D. C. Entered as second-class matter at Post Office, Washington, D. C. under Act of March 3, 1879. Subscription rates: 1 year (6 issues), $4.00; 3 years (18 issues), $10.00; to members of Army Signal Association, 1 year (6 issues), $3.00.

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CHANGE OF ADDRESS: When sending change of address, please give both the old and new addresses and allow 3 weeks for first copy to arrive.

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Our Cover

The Lockheed P-80 is capable of speeds well in excess of 500 miles per hour.

The orange border on the cover of this issue is the official Signal Corps orange as secured from Heraldic Section, Q. M., Washington.

This Issue

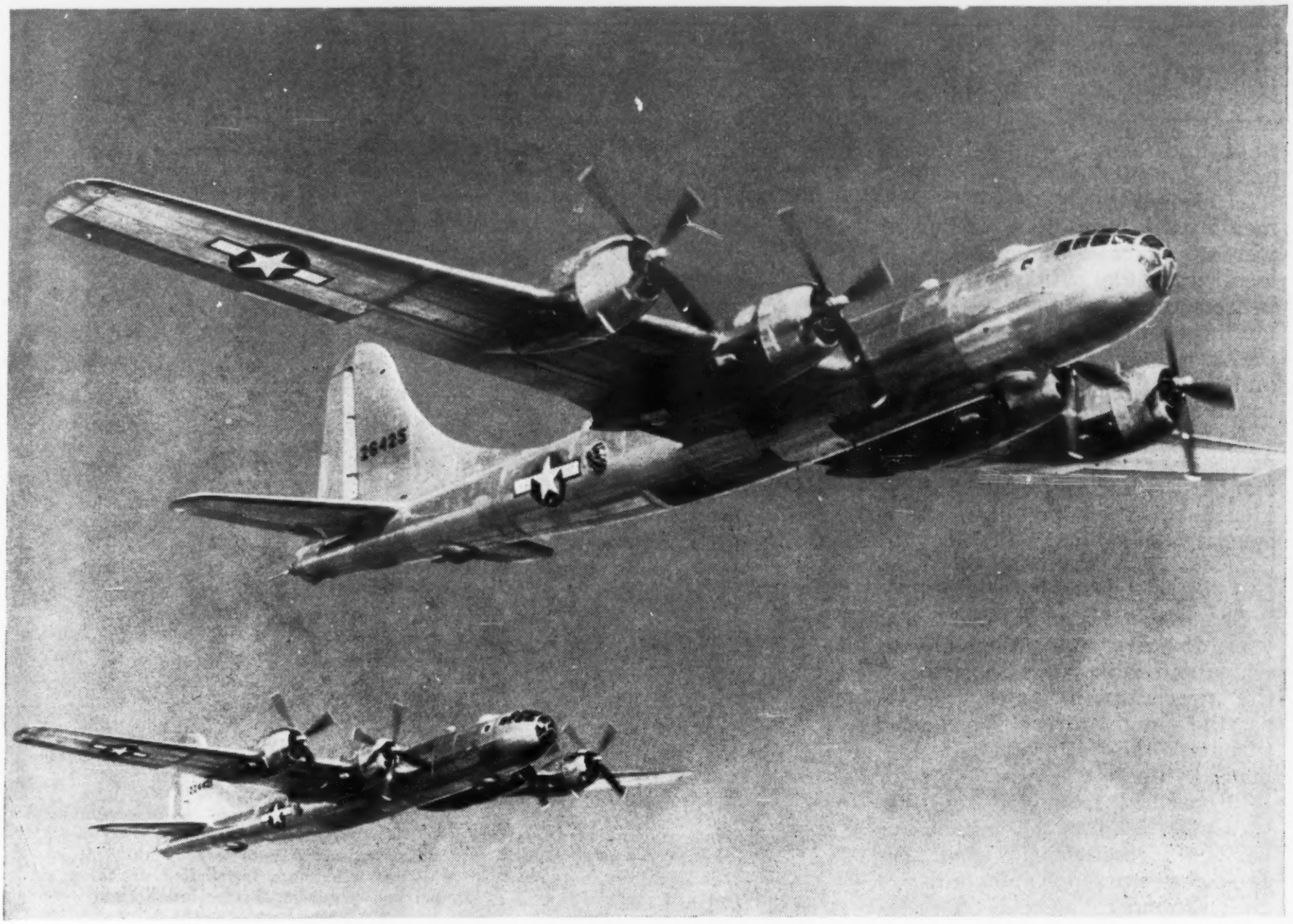
Devoted to communications, radar and electronics in the Army Air Forces.

Photo by Lt. John F. Fixus

This striking view of Vesuvius' 1944 eruption was made through an infra-red filter. Mountain is 55 miles distant, across Campanian plain. Near Capua, Italy.

SIGNALS

VOLUME I NOVEMBER-DECEMBER, 1946 NO. 2



ELECTRONICS IN THE AIR FORCES

By Francis C. Byrnes

Communication, Radar, and Navigational Aids Are the Nerve Centers of Aerial Warfare

HIGH IN the skies above Yawata, the "Pittsburgh of Japan," a radio transmitter added its hum to the steady roar of four powerful, throbbing engines. In an operations room near Chengtu, China, two thousand miles away, a small group of men stirred eagerly, checked their watches. As the words, "Betty, Betty," snapped through the radio receiver, a sign of jubilant relief swept the room.

Years of research and engineering, months of grueling training and intricate briefing had prefaced this moment. That brief message, code for "objective hit," sounded the beginning of the end of Japan, heralded a new era in aeronautical and electronic achievement.

Into each of the Super Fortresses participating in that initial B-29 raid on the Japanese homeland in June, 1944, had gone the best of tried and proved airborne electronic equipment. Product of the combined efforts of hundreds of electronic engineers, scientists and manufacturers, the twenty different radio and radar sets carried by each B-29 represented a total weight of 2,000 pounds, the largest single installation of electronic equipment ever made in an operational aircraft of the Army Air Forces.

Without minimizing the superior characteristics of the Super Fortress which inaugurated long range, high altitude military flight, it was the electronic equipment employed that made possible long distance navigation, precision bombing and safe return to base.

In addition to the bombing through overcast radar system and the long range navigational receivers (Loran), both of which were particularly essential to successful B-29 operations, these aircraft carried radio and radar

equipment to provide for all communication and navigational requirements.

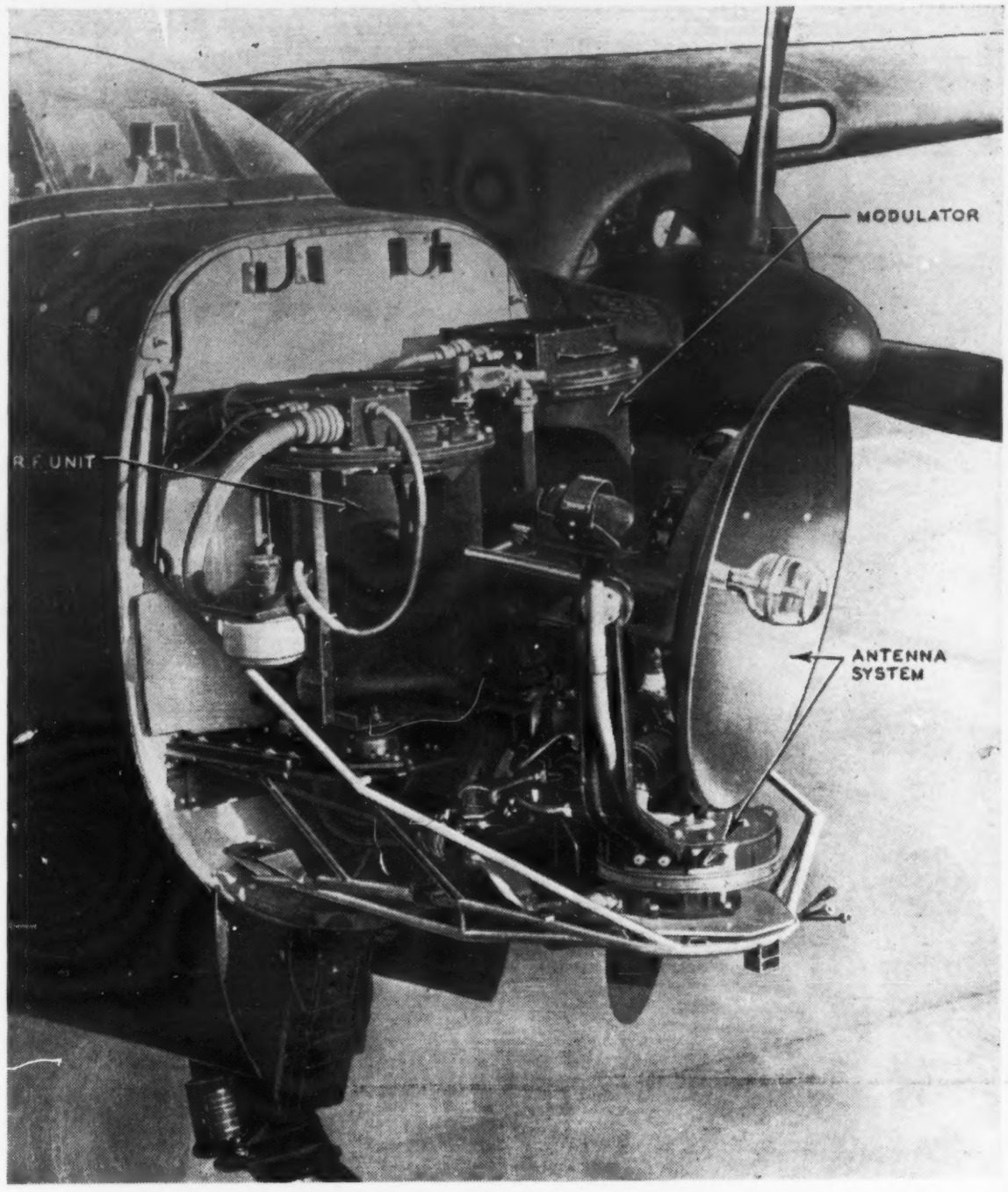
Communication equipment included the push-button controlled, VHF command set; the 11-channel, automatic-tuning liaison transmitter, capable of long range transmission and satisfactory performance at altitudes up to 40,000 feet; the high altitude interphone, providing a communication link between the pilot and every crew member; and a liaison receiver.

Electronic navigational instruments used, in addition to Loran, were: automatic radio compass; localizer; glide path and marker beacon receivers to permit safe landings on strips obscured by darkness or unfavorable weather; and the radar precision altimeter to give height above terrain.

As with other operational aircraft, B-29's were supplied with standard interrogator-responsor identification equipment, while a special IFF set was employed to operate with the radar fire control system installed in the tail.

Specially designed electronic wick dischargers installed on the wings and tail materially reduced the precipitation static created as the huge aircraft streaked through the atmosphere. Depending upon the mission, each B-29 carried from one to four transmitters for jamming the various frequencies used by Japanese warning and anti-aircraft ground radar sets, plus special receivers and analyzers for monitoring enemy transmissions. Should the B-29 crash-land in the ocean, each aircraft was equipped with the famous Gibson Girl sea rescue set, which transmits a signal on which searching aircraft could home. Since a rubber life raft does not reflect a perceptible radar echo when radar-equipped aircraft are being used for locating fliers down at sea, a screen-like device, known as a corner reflector, was also included.

That the B-29 electronic equipment was standard is truly indicative of the rapid strides made in the past 10 years, and particularly during World War II, in the development of airborne electronic equipment. Equally so, it emphasizes the AAF's recognition of, and dependence upon, electronic equipment for the safe and effective operation of aircraft, both in peace and war.



Air Corps Photo

Product of combined electronic and aeronautical planning, the P-61 Black Widow was designed around the radar equipment necessary to make it an effective night fighter. Shown here is the P-61 nose installation of antenna, RF unit and modulator of a radar gun laying system. Similar installations were made for aircraft intercept radar.

Never in history has a military weapon been so dependent upon communications, navigational and tactical aids as the modern aircraft. Every aeronautical advancement has established new electronic requirements, and, conversely, discoveries and applications of new electronic techniques and phenomena have made possible further progress in aviation.

Soon after Kitty Hawk the problems of airborne communication and aircraft navigation were recognized. Telegraphy from captive balloons was practiced as early as 1861, but little was learned which was applicable to free flight. The Army's infant Air Service, then a branch of the Signal Corps, made the first air-to-ground contact by radio in 1911, using standard ground communications components and a wind driven generator During World War I, little progress was made toward developments strictly for airborne use, and existing ground equipment was modified for aerial communication.

Formal attention to solution of the particular military requirements for aircraft radio was initiated in 1920 with the activation of a radio unit in the Equipment Branch of the AAF's Material Division located at McCook Field, Dayton, Ohio, and the establishing of the Signal Corps Aircraft Radio Laboratory at the same field in the early Twenties.

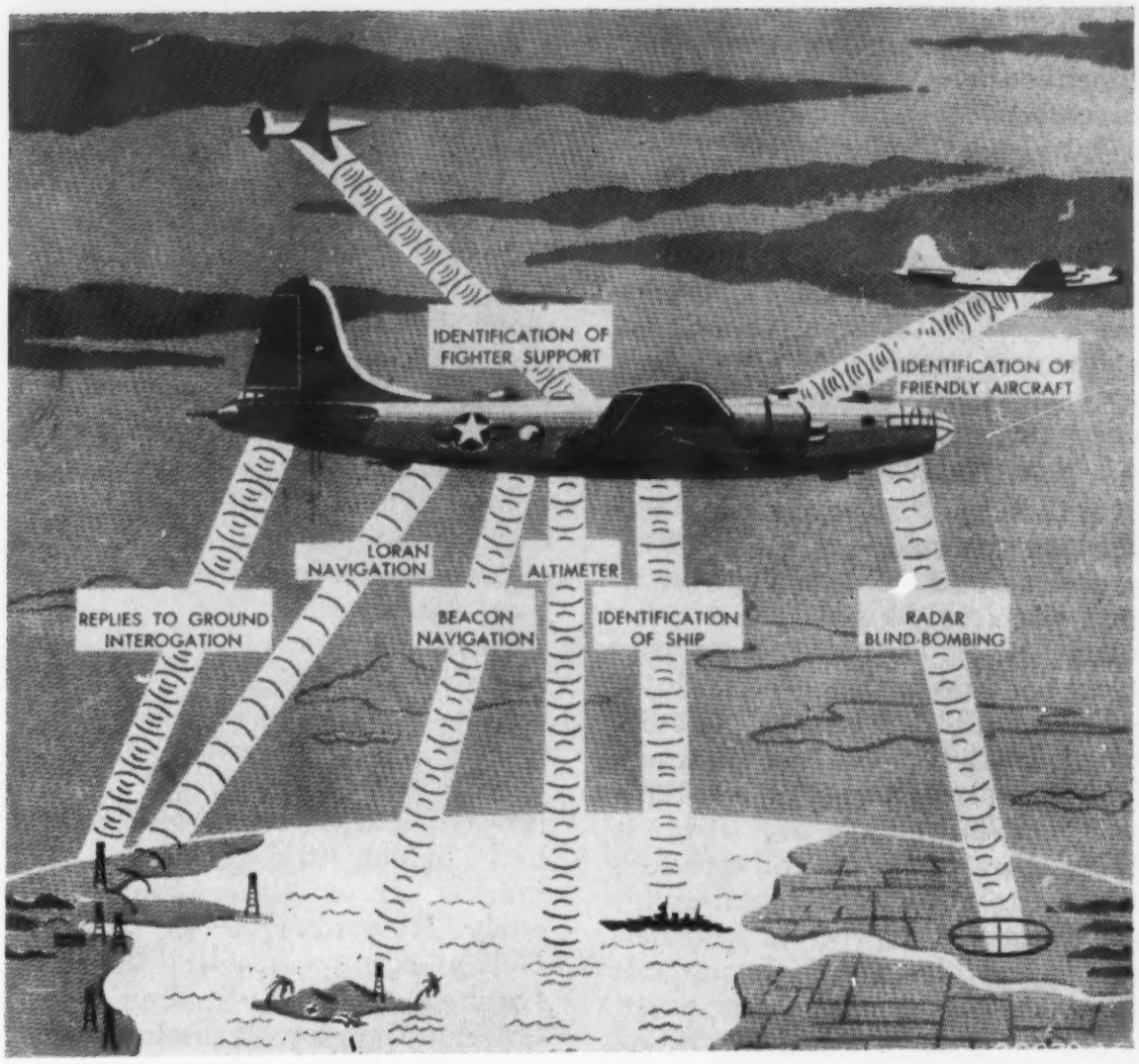
By 1927, when the activities of McCook Field were transferred to a location east of Dayton and renamed Wright Field, many early electronic investigations were underway. First SCARL director was the late Colonel William H. Murphy (then captain) for whom one of the Signal

Corps radar training centers, Camp Murphy, was named. Col. Murphy was killed in the Pacific theater early in the war.

With the reorganization of the Signal Corps' Aircraft Radio Laboratory at Wright Field in 1935, the development of airborne electronic equipment both for communications and navigation, became a major objective. Located in the heart of AAF aeronautical research and development, the Laboratory's civilian and military engineers were exposed to the problems of aeronautics. Under the jurisdiction of the Signal Corps, they had the cooperative assistance of those who served the crossed-flags at other development laboratories.

When threats of war became evident in the late Thirties, it was in this Aircraft Radio Laboratory, where air-minded Signal Corps men exchanged views with communication-minded aviators, that electronics and aeronautics were effectively joined to build air power. Here, efforts were renewed with increased vigor to solve those electronic problems peculiar to airborne operation. Radio sets for aircraft had to be lightweight, compact, and easy to install, operate and maintain. Problems were created by high altitudes, extreme variations in temperatures and pressures, moisture condensation, precipitation static, terrific vibrations and shocks, and varying forces of gravity. Thousands of hours were spent solely on designing antennae and installation techniques satisfactory for the various types of aircraft.

While working with research organizations and private industry in seeking solutions to these problems, the Aircraft Radio Laboratory simultaneously saw in the electronic field aeronautical applications other than communications and simple navigation. Experiments with modified ground radar sets demonstrated the feasibility of using pulsed radio waves to detect targets and determine altitude above the terrain. Modification of early British systems for aircraft interception led to development of radar for night fighters, and later to radar systems for controlling aircraft guns. Application of radar techniques to beacons resulted in portable beacons used to guide



The B-29 is sometimes referred to as a flying radar set. The functions of five types of radar equipment are shown here.

paratroopers and gliders in the invasions of Sicily and Normandy, in improved identification systems and still later to the extremely precise navigational system known as Shoran.

It is impossible to give individual credit here to the hundreds of individuals, both military and civilian, responsible for the design, development and engineering of the many electronic devices employed by the Army Air Forces. Mention will be limited to a few of those men, closely associated with the Aircraft Radio Laboratory immediately prior to and during World War II, whose vision, devotion to duty and capabilities were particularly significant in the development and production of airborne electronic equipment.

Francis C. Byrnes was separated from the service as a Lieutenant Colonel in May 1946 after 4½ years' duty with the Signal Corps and AAF. More than three of those years were spent at Wright Field as officer in charge of the Technical Information Branch. He also served for a year in the Radio and Radar Division, Office of the Chief Signal Officer. At present, Mr. Byrnes is Chief, Technical Information Branch, Operations Section, Engineering Division, Air Materiel Command, Wright Field.

Until his death in 1943, Brig. General John H. Gardner, was one of the driving forces in the field of airborne electronics. As a Signal Corps major, he was appointed director of the Aircraft Radio Laboratory in 1939 and personally initiated and accelerated the development and engineering of electronic equipment for AAF use.

When, in the early months of World War II, the demands of the AAF for airborne electronic equipment began to mount, General Gardner was selected to establish and direct an organization to coordinate and supervise all the various Signal Corps agencies responsible for developing, procuring and issuing electronic equipment for the AAF. This organization, the Signal Corps Aircraft Signal Service, formed in May, 1942, also became responsible for continuing the training of radar maintenance personnel recommending standard maintenance practices and furnishing instructional literature on the hundreds of new radio and radar sets in production.

Measured in dollar volume, production of airborne electronic equipment had expanded so rapidly that it already exceeded all other combined supply activi-

ties of the Signal Corps. Overnight, development contracts for experimental models were being converted into production orders for hundreds of sets. Never had the division between engineering and production been so indefinite. Research and development moved forward with tremendous speed; today's design would be as obsolete tomorrow as yesterday's was today. It was said that every time two engineers met a new radar set was conceived.

In this fluid situation General Gardner carried out his widespread responsibilities vigorously and effectively while the procurement of airborne electronic equipment grew from a total delivery of 192,522 sets of 69 different models prior to January 1, 1942, to a delivery of 5,051,395 sets in 500 models by July 1, 1943. Development and production techniques established under his direction served to the advantage of the AAF throughout the war.

When General Gardner was transferred to the Office of the Chief Signal Officer in July, 1943, to assist in expediting general Signal Corps procurement, a major streamlining reorganization in the Dayton area separated the development and procurement activities. Colonel W. J. Daw, who had served as General Gardner's production chief under the Signal Corps Aircraft Signal Service, became head of the Dayton Signal Corps Porcurement District and Dayton Signal Depot. Colonel Hobart R. Yeager, director of the Aircraft Radio Laboratory under SCASS, became commanding officer of the Signal Corps Aircraft Signal Agency, responsible for development and maintenance activities.

Coming to ARL in 1939 as an Air Corps officer on detached duty with the Signal Corps, Colonel Yeager, in addition to four years of active laboratory experience in electronics, had been assigned almost continuously since 1925 to communications activities of the AAF. A command pilot, Colonel Yeager was ably equipped to translate to the Signal Corps engineers the needs of AAF flying personnel. He organized the laboratory's first radar program in 1939 and personally engaged in many of the early experiments with new electronic equipment, often serving as pilot when it was necessary to test new devices in hazardous weather.

Under his direction, field facilities for flight and operational testing of electronic equipment were established at Boca Raton, Valparaiso and Florosa, Florida, and another at Indianapolis, Indiana. Development expenditures, which had increased forty times, and production of equipment twenty-six times, within the first 18 months of war, were being "written off" in the successful employment of airborne electronic equipment in all theatres of war.

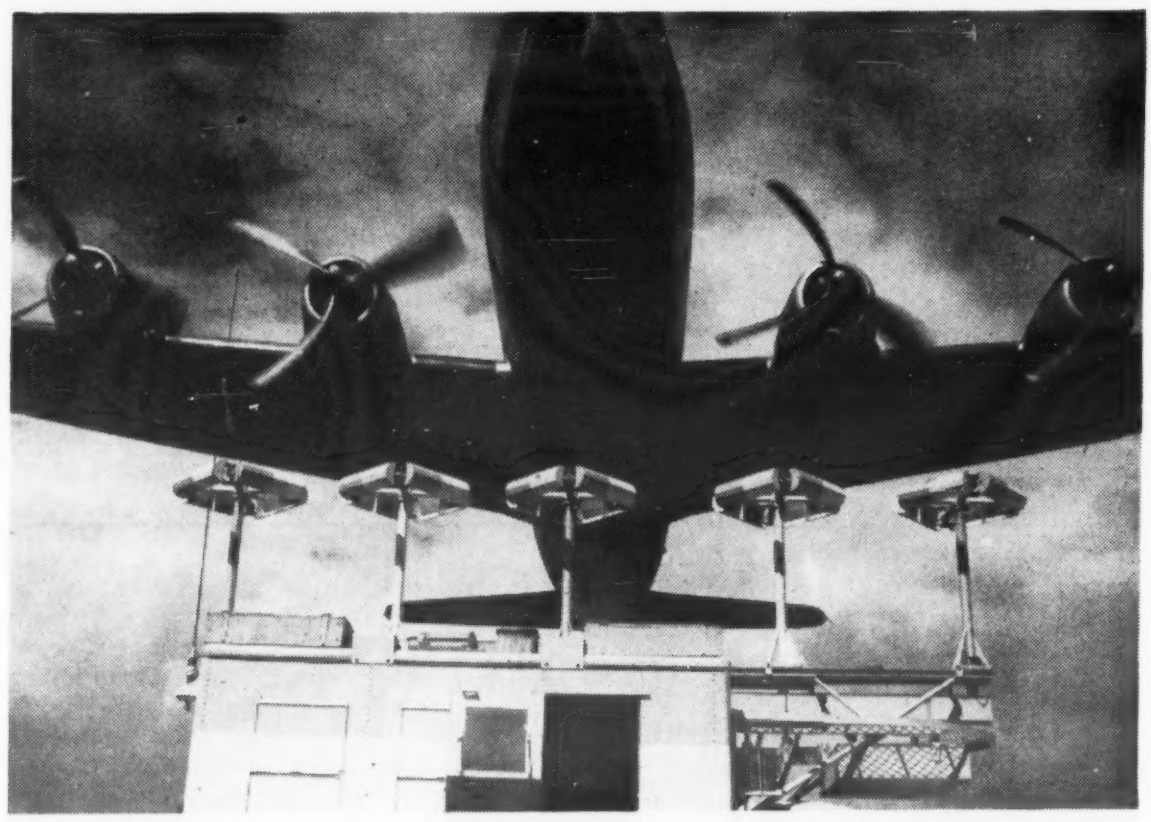
But the war continued, and the demands of AAF climbed upward—the AAF had seen what electronic equipment could do, wanted it to do more. Search radar and the long range bomber had driven the German submarine from the Atlantic; in early November, 1943, thirteen B-17's equipped with the first bombing radars wreaked havoc on cloud-ridden Wilhelmshaven; low altitude bombing radars had become the scourge of Japanese shipping in the South Pacific; precision altimeters were saving lives and aircraft in navigation over the "Hump," as were instrument landing systems throughout the world, especially in fog-ridden Alaska and England.

Under the direction of Colonel Yeager, the Aicraft Radio Laboratory exercised a unique role in research, development, engineering, testing, contracting and installation activities. This Laboratory was responsible for guiding airborne radio and radar research in government, university and commercial laboratories, adapting theoretical research to technological problems, engineering the quantity production of millions of dollars of equipment and fitting the complicated devices into AAF aircraft as workable systems.

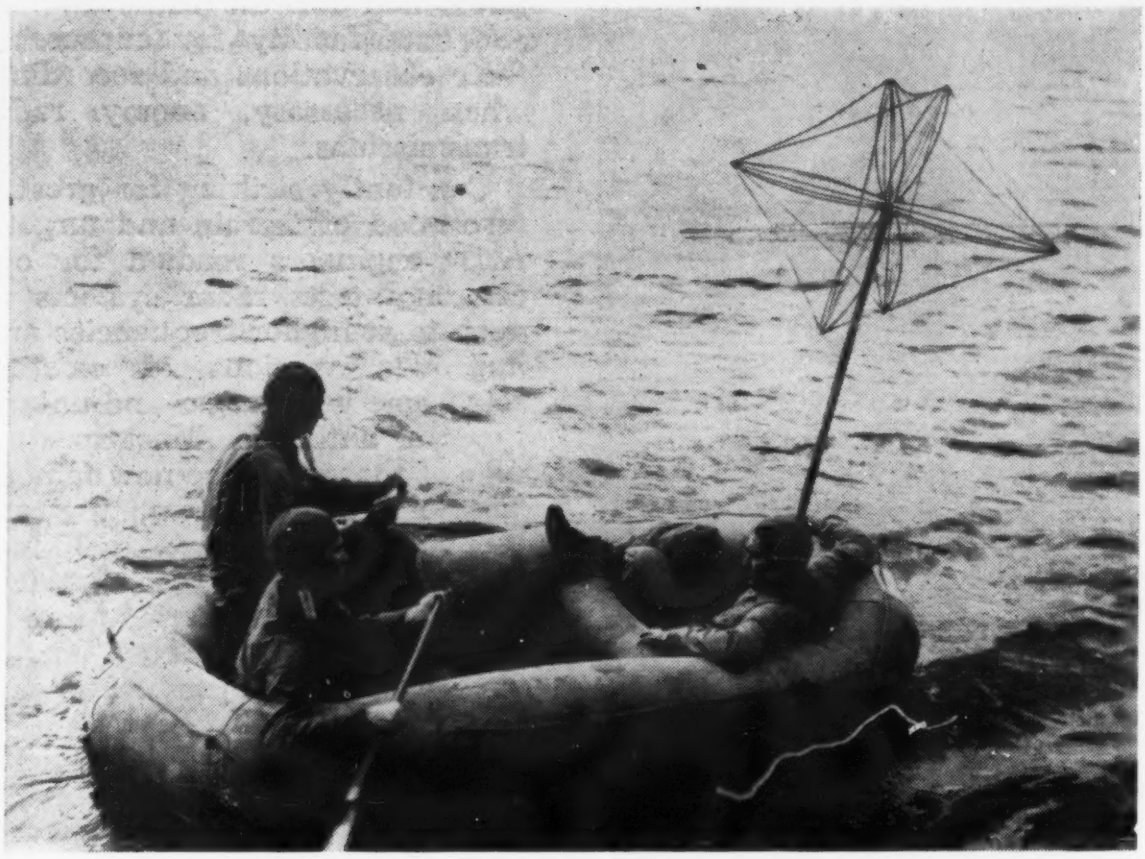
Among the individuals whose outstanding efforts contributed directly to the successful execution of the Aircraft Radio Laboratory's responsibilities were Colonel Wayne G. Eaton, Colonel George F. Metcalf, Colonel George L. Haller, Lt. Colonel Francis Moseley, and Lt. Colonel I. H. Gerks.

Colonel Eaton, civilian employee of the laboratory prior to the war, was responsible for technical administration of the laboratory and for establishing standards of design and performance of airborne equipment, for reducing those characteristics to specification form suitable for use by industry, and for methods and procedures covering inspection, test, and acceptance of model and quantity production of communications equipment.

Successful tactical employment



Right down the slot. An Air Forces pilot "under the hood" in simulated blind landing approach flies this C-54 down the runway and directly over the mobile unit that brought him in on a beam. This GCA, or Ground Control Approach System, is one of two such mobile units that guide AAF aircraft in for landings during bad weather.



"Corner," a radar which guides rescue aircraft to airmen who have been forced to abandon their airplane and take to boats in the open sea.

of airborne radar equipment for precision bombing and aircraft fire control was in a large part due to the activities of Colonel Metcalf. Entering military service from industry, Colonel Metcalf was first assigned to coordination of radar development activities in the Office of the Chief Signal Officer, and later went to ARL to supervise the airborne radar development program. During his assignment at Wright Field, he spent several weeks in both the European and Pacific theatres assisting tactical organizations in the planning and execution of airborne radar operations. He also designed and developed a tail warning device for fighter aircraft. This radar set flashed a light and sounded a bell in the cockpit when enemy aviators attempted a sneak attack from the rear.

Thousands of AAF pilots and air crews owe their lives to the AAF Instrument Approach System which made possible landings in all types of weather. Through the relentless efforts of Lt. Colonel Moseley the system, on which he had experimented prior to entry on active duty in 1941, was prefected and universally adopted by the AAF and Royal Air Force. Later he evolved a tie-in of the system with the standard autopilot, making it possible to automatically land an aircraft with electronics.

In the "high-frequency war" that resulted from extensive employment of electronics by both sides in World War II, Colonel Haller, a former civilian employee of ARL, formulated and implemented the research, development, design and improvement of radio and radar countermeasures for the AAF. During the war, more than $150,000,000 was spent by the AAF in the engineering and procurement of these electronic devices to protect operations by jamming, confusing and deceiving enemy radar operators. In addition to the many different sets developed under Colonel Haller's supervision, he was closely identified with the design and equipping of the flying intelligence centers, known as Ferrets, which were used to locate and analyze the frequencies of enemy radio and radar transmitters.

Intensive efforts toward designing and improving communications facilities for the AAF was achieved by Lt. Colonel I. H. Gerks, who directed communication and navigation development during the early part of the war. He supervised the extensive engineering modifications made on a British communications set which resulted in the four-channel VHF command radio receiver-transmitter used widely until the later stages of the war. In addition, his work in suppressing and eliminating the electrical interference generated by high-powered aircraft motors substantially contributed to the improved performance of all types of airborne electronic equipment.

Others who contributed substantially to the support and execution of the airborne electronic program included: Major General Roger B. Colton, first in the Office of the Chief Signal Officer, and later in the air communications offices of the AAF in Washington and at Wright Field; Major General H. M. McClelland, war-time AAF air communications officer; Colonel William L. Bayer, chief of ARL radar activities early in the war; Colonel Daniel P. Doubleday, who directed much of the airborne electronic installation and test activities, and Colonel Gilbert Hayden, executive officer of SCASS and SCASA.

Among the other Signal Corps officers who directed the research and development activities of ARL in its pioneer days were: Captain Paul S. Edwards (later Colonel), Major Hugh Mitchell (later Colonel), Major Louis B. Bender (later Colonel), and Colonel J. O. Maubornge (later Major General and Chief Signal Officer).

Principal activities working with ARL in the research and development of airborne electronics equipment, especially new radar and countermeasures devices, were the laboratories being operated under the National Defense Research Council and those of the commercial electronic industries.

By the spring of 1944, wherever men flew they were dependent upon electronics for navigation and communication, and for the dozens of other special applications necessary to gaining and maintaining air supremacy. Simple radio control sets, developed for guiding target airplanes, were modified and used to steer falling bombs into strategic bridges in Burma and Italy. Radio control and television had joined forces for strikes against other targets. With radio signals, the bombardier in the lead plane of a squadron could simultaneously drop the bombs from every aircraft in the formation. Radio and interphone links had been perfected for operation between gliders and tow planes, and

escort fighter aircraft in the Pacific were guided by electronic homing devices to rendezvous points in mid-ocean marked by buoy transmitters. After five years of intensive effort on the part of ARL and industry, the short range precision navigation system, Shoran, was making bombing history in Italy, while B-25's equipped with 75mm. cannon and fire control radar blasted Japanese barges from the Yangtze River in China.

The AAF had become the world's greatest consumer of military electronic equipment, exceeding both the Army Ground Forces and Navy. Electronic equipment represented approximately 25 per cent of the cost of bomber aircraft, such as the B-29, compared with 1.5 per cent of the cost of the less expensive B-17. Even further, design of new aircraft could no longer be considered independently of plans for the electronic equipment the aircraft would carry. Nearly ready for service test were the first of several different models of jet fighters; on the drawing boards were plans for new aircraft that in a few years would make the B-29 completely obsolete. Aircraft were being designed and built to fly higher, faster and farther than had been dreamed possible. In every plan, new electronic problems were arising, problems common only to electronics for aviation. Thus, in October, 1944, by direction of the Chief of Staff, all responsibility for development, procurement and maintenance of electronic equipment peculiar to the air forces was transferred to the AAF, along with the personnel and facilities.

Affected 100 per cent by this action, the Signal Corps Aircraft Signal Agency with its principal component activity, the Aircraft Radio Laboratory, became the Electronic Subdivision of the Air Materiel Command's Engineering Division at Wright Field. Colonel Yeager continued as chief until his transfer to a Pacific assignment in August, 1945, when he was succeeded by another veteran in electronic research and development for the armed forces, Brig. General Tom C. Rives, who had served from 1930 to 1935 as director of airborne electronic development activities at Wright Field.

Air Corps Photo

Brig. General Tom C. Rives, long associated with the development of airborne electronics equipment, and currently chief of the Electronic Subdivision, Engineering Division, Air Materiel Command at Wright Field, where AAF engineering activities on this equipment continues.

Despite the urgency of meeting production schedules and reorganization the research and development of airborne electronic equipment progressed rapidly throughout 1944 and to the end of the war in 1945. Emphasis placed throughout the war on reduction in weight, simplification of controls, incorporation of automatic operation and increasing of reliability and range had compounded into significant results.

New VHF transmitter-receivers (standard equipment for practically all aircraft) now had eight push-button-operated channels, plus provisions for automatic tuning with a change in crystals. Weighing 40 pounds less than the four-channel equipment it replaced, this set rivaled the weight and space economics achieved with the new 11-channel, automatic tuning liaison transmitter which saved 85 pounds and six cubic feet.

Automatic radio compasses were replacing manually-tuned equipment, and a new Loran receiver eliminated two steps from the procedure necessary to establish a position fix. With improved microphone and headsets, and a special amplifier, interphone conversation at high altitudes became easier, more intelligible. In the revolutionary new airborne wire recorder, reconnaissance pilots had for the first time an adequate facility for expressing their observations and recording, when necessary, enemy radio transmissions.

Constantly striking for greater resolution of terrain and targets, AAF engineers readied for operational tests radar systems to operate at higher frequencies and improved versions of existing sets, some with larger and unique types of antennas. Most spectacular of these was the now famous "Eagle" radar system, the antenna for which was a 16-foot linear array of dipoles housed in separate airfoil carried underneath the aircraft. The "Eagle" was rushed into production and installed on B-29's of the 315th Wing which arrived in the Pacific theater a few months before V-J Day. In bombing through overcast on strategic Japanese targets, such as oil refineries, the performance of "Eagle" surpassed that of all previous radar sets and rivalled the accuracy of the standard AAF bombsight against visual targets.

Further progress in radar was made with the development of a new search system weighing only 125 pounds. Comparable in performance to the 500-pound unit used early in the war for submarine detection, this new equipment, for the first time, made feasible the installation of radar search systems as navigational aids in transport and other smaller aircraft of the AAF. In addition, this new system incorporated special features for detecting storm fronts and determining altitude.

War-proved as an inseparable combination, the sciences of electronics and aeronautics are making rapid strides toward full maturity in the post-war period. Guided missiles and supersonic aircraft impose even more stringent requirements for electronic controls and facilities.

Top priority objectives of the AAF—including all-weather flying, automatic flight control and landings, airways and airport traffic control, interference-free communications—are reflected in the current electronic research and development program, as are those projects necessary to furnish the AAF with the radio and radar equipment required for effective defensive and offensive action.

EDITORIAL

Hiroshima

Have you read John Hersey's article on the atom-bombing of Hiroshima? It is a terrifying picture that he paints—especially if we transfer in our imagination the locale to our own community. Our members do not need to read the article to influence them to a determination that America must maintain military strength until we find some other method of insuring against a "Hiroshima" in our USA. We have no slogan in ASA. "National security through military preparedness" would be a suitable one.

Esprit De Corps

In the September issue of SIGNAL BULLETIN we mentioned the War Department's splendid plan to form military units from commercial organizations —so-called "affiliated units." Pride in the "parent company" would add tremendously to the value and efficiency of these units if they were called to the colors. That is called "esprit de corps" in the Army which emphasized its value in its peacetime teachings only to ignore it too frequently when war came. It has been said that "battles are won by young soldiers who have pride in themselves and in their units." Entirely too often in forming, designating or inactivating units there was an inexcusable disregard of the stimulating potency of tradition to soldiers. In the Signal Corps, one of the few units that had any tradition was the 51st Signal Battalion, which had a published history going back to World War I, a special march dedicated to it by the composer, a coat of arms and motto. The Battalion was known to Reserve, National Guard and Regular Army personnel from Texas to the Canadian border because of its participation in all large scale maneuvers. Nevertheless, when it became necessary to inactivate a Signal battalion during the war in the MTO, some individual without an understanding of military history and tradition designated the 51st for inactivation. Action initiated in Washington, finally saved this fine old unit from oblivion. The War Department General Staff should establish and adhere to a policy which will insure that wherever possible units with a tradition be kept alive, especially these new "affiliated units." A recent report from Berlin that the 3rd Infantry—the oldest military unit in the Army—is being inactivated this month, indicates that the War Department has not yet established such a policy.

Air Power

According to the publication U. S. AIR SERVICES, the Curtis Publishing Company has made a survey to determine the opinions on military aviation by the man in the street and his associates. The most important finding, to our way of thinking, was that only one per-cent of the people showed any semblance of appreciation of what air power really is and thought that air power is only military aircraft. This type of thinking has handicapped America in the past in maintaining adequate preparedness. Mr. Bryan's famous remark that a million men would spring to arms overnight if the U. S. were threatened was never so wrong as it is today. ASA exists to combat that sort of thinking, especially in the communication and photography fields. Not only is there much labor and thought needed in the industry, but universal military service, which will accomplish so much toward readying the technician, and the operator of complicated combat and supporting equipment, is an essential which should be immediately realized. Dr. Karl Compton and former Ambassador James C. Grew are two of many thinking leaders of America who support the efforts of the military to adopt universal military service now, not alone in anticipation of another war, but to make this a better America with better Americans.

Our membership includes former enlisted men and officers; enlisted men and officers on active duty overseas and at home, in the Air Forces, the Ground Forces, and the Technical Services; technicians in manufacturing plants; women in the services and out; executives; big and small manufacturing and operating companies. We try to balance our magazine with articles which will appeal to each of these groups.

History

General McNarney and those in the War Department who decided to form a constabulary force as the principal instrument of our occupation of Germany are students of history and therefore did not need to read Henderson's "Stonewall Jackson and the American Civil War" to convince them that quality instead of quantity should be the objective in Europe. Those who have read this book will remember that it was stated that the cooperation, in the early months, of one good Army corps of 35,000 men (and that is the approximate size of the constabulary in Germany) would have given complete victory to the side on which it fought. The book states further that it is impossible for anyone who understands the power of organization, of discipline, of training and of a proper system of command to dispute the accuracy of this statement. We apparently are fast providing a highly trained force which is calculated to reflect credit on our country in the eyes of the people of Europe, especially of Germany. Major General Ernest N. Harmon was selected to command these troops, no doubt because his entire career, from his earliest indoctrination in military discipline while a cadet at the U. S. Military Academy, through his attendance at the top level Army schools, until his successes as a battle commander in Europe, has demonstrated that he is an exponent of efficiency, discipline and the other qualities mentioned by Lord Wolseley. We can soon be proud of our peacetime military ambassadors under General Harmon's command in Germany.

Report

Every American interested in national defense should read General Marshall's Biennial Report as Chief of Staff published a year ago. It is fascinating reading. Scarcely less interesting is General Eisenhower's report as Supreme Commander in Europe. Of special interest to the members of ASA who have an appreciation of the part industry played in the victory and can play in keeping us from again being attacked, is the conclusion reached by SCAEF: "Throughout the struggle, it was in his *logistical inability* to maintain his armies in the field that the enemy's fatal weakness lay. Courage his forces had in full measure, but courage was not enough. Reinforcements failed to arrive, weapons, ammunition and food alike ran short, and the dearth of fuel caused their powers of tactical mobility to dwindle to the vanishing point. In the last stages of the campaign they could do little more than wait for the Allied avalanche to sweep over them." As far as Germany was concerned, the reason these essentials were lacking was the Allied air forces, to which General Eisenhower gave full credit, noting that "long before we landed in France, the heavy bombers had begun their task of *destroying the centers of production* upon which the enemy relied, and the fruits of this effort were evident immediately the land campaign began. Following the invasion, these strategic blows at the *heart of German industry* were continued and the task was also undertaken of *cutting the supply lines which linked the factories to the front.*"

It seems quite in order to conclude that the biggest lesson of World War II is that, above all, the victorious power in modern war must have an efficient, experienced, patriotic and intelligent industry engaged in designing and building better equipment for the fighting men now—not one or two years after the beginning of the war. This means peacetime planning *now*—and participation in it by *all* of industry.

Emblem

Our newly adopted insignia appears for the first time on the front cover. The central figure is an alert powerful American eagle with strong talons clutching lightning flashes—symbolic of a strong America insofar as national defense and especially modern communications are concerned—our basic reason for existence. The border consists of leaves of the olive branch of peace, showing that the object of military preparedness in America is to assure a lasting peace. In the background are signal flags—the first means of signaling in the U. S. Signal Corps and a method still used for special purposes in the armed forces. Just above the eagle and between his outstretched wings, is a heavy bomber in flight, symbolizing the complicated and essential communications in the Air Forces, both intra- and inter-aircraft, air-ground, and on the ground. Above that is a radar antenna array and at the very top a radio relay antenna—for the latest major step in military communications. And none of these could exist without industry—the foundation of ASA. In the color version there are the traditional colors of the signal flags—dexter white flag with red center and sinister red flag with white center—with a gold border to the whole. Since communications and communications equipment are essentials in every one of the armed forces, each of which has an official color or colors, it was decided not to include any branch color in the coat of arms since all could not be shown.

New Cover

Will you compare the style of our cover this month with the one on the first issue? This time we are using a more modern design with "speed" lettering, which is certainly symbolic of modern communications. Will you let us know whether you prefer this to the more conservative cover layout?

The Highest Traditions

The recent untimely death of General Joseph W. Stillwell, as the result of illness contracted or aggravated during his arduous wartime service in Asia, profoundly impressed the American people. Only 63 years of age, not yet fortunate enough to enjoy the pleasures and relaxation of retirement, he was too young to die. He was beloved by the men of his command; had a reputation for courage in battle and for leadership not exceeded by any officer or soldier in our history. His ability was recognized when he was awarded the oak leaf cluster to the DSM for his Burma service during which "his responsibilities were of tremendous magnitude and complexity and his accomplishments were far beyond even optimistic expectations." His devotion to duty was emphasized by his statement, almost at the start of the campaign in China and Burma, that he was fighting a war and couldn't spare the time to be sick or to take care of his health.

Truly, high ideals of service to his country cost him his life.

As we heard his death announced over the radio and read the eulogies and accounts of his military career of over forty years, we decided it would be timely to do some research and see whether there were many other top leaders of the Army who had contributed as much through ideals of service to country as General Stillwell has now given. The results are revealing. These figures will bring home the fact that these men who have spent a lifetime in service to country did not shirk their duty nor avoid danger. When one reads the statistics he realizes what is meant by the "highest traditions of the military service."

The casualties among general officers total exactly 100. This means 5% of the 2,000 individuals who held general officer grade during the war; however, considering that there were never more than 1,500 in that category at any one time, the percentage is raised to 6⅔%. This figure is only slightly less than the casualty rate for enlisted men of the infantry and far above the rate of less than 1% of all who served in the Army during World War II.

First class of the newly resumed AAF pilot training course matriculated 15 October. A total of 575 officers comprise the student-body.

Through the A.P.S. Lens

The Army Pictorial Service functioned in every combat zone, on every battle front, in every theater of operations. Wherever our troops went, from Guadalcanal to Bombay, Greenland to Rome, Tunis to Natal, a Signal Corps camera was close at hand.

Still and motion pictures made by A.P.S. were highly instrumental in streamlining the gigantic task of training an eight-million man Army. When these soldiers went into the field, A.P.S. entertained them. When they went into battle, Army photographers recorded their achievements for historical and tactical study.

During the period, 1942-45, A.P.S. produced more than 2,000 training films and a similar number of film strips. The Overseas Motion Picture Service branch operated 21 film exchanges in every Theater of War. A total of 43,306 feature pictures, in 16mm prints, and 33,236 short subjects, were distributed, with the cooperation of the Hollywood motion picture industry.

Indicative of the tremendous audience reached by these films are the figures for the night of 1 June 1945. On that evening, in overseas theaters alone, 1,900,000 service men attended more than 6,000 separate showings of OMPS films. Using this figure as a median and taking an average of two shows per week, a conservative minimum of 650,000,000 military personnel attended Army motion picture showings, in overseas theaters alone, during the war. Staggering as these statistics are, they cover but a single phase of the activities of A.P.S.

SIGNAL CORPS MOVIES

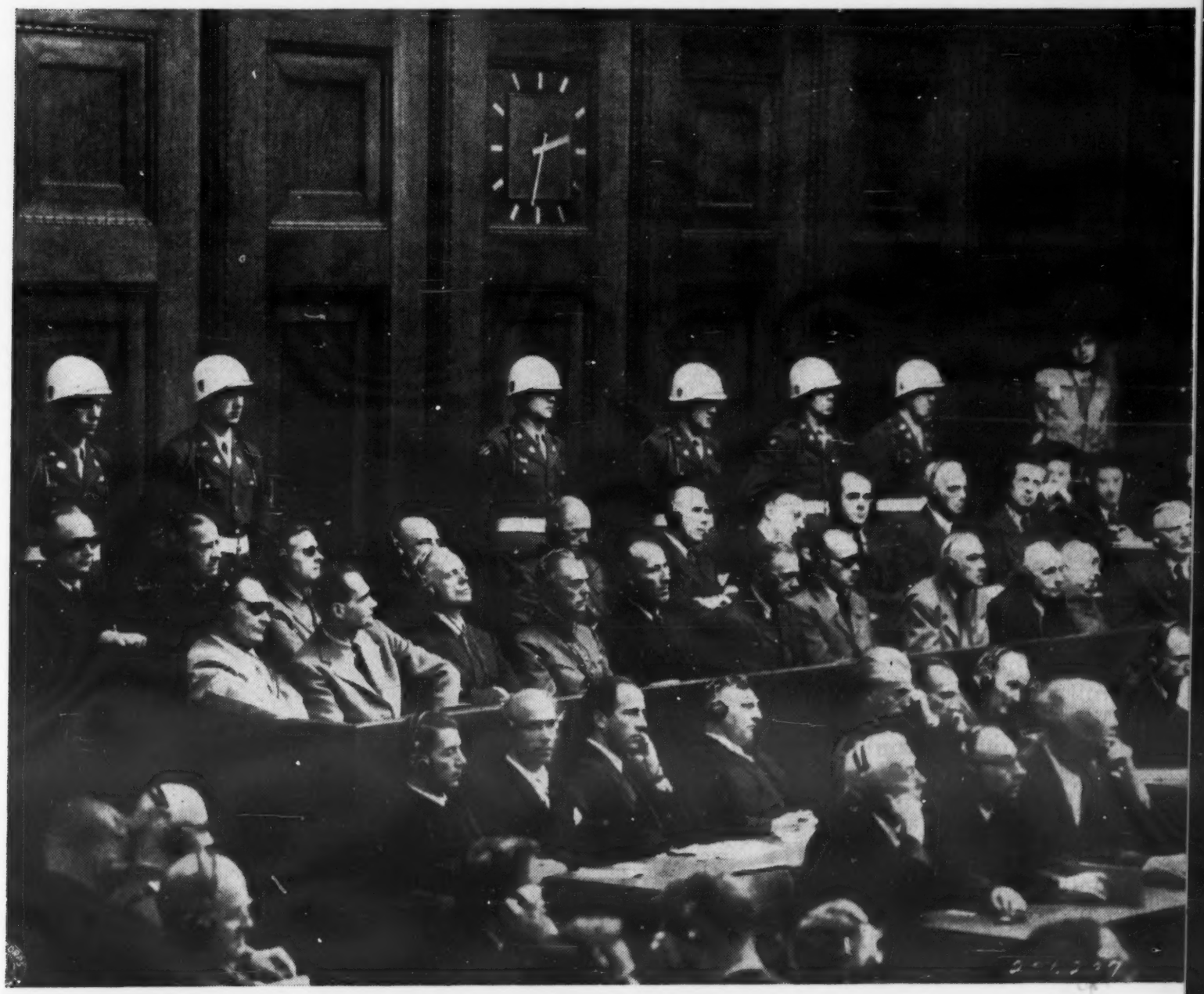
in production at Astoria, Long Island. Training films were highly instrumental in preparing an effective fighting force in the minimum time.

APS IN ACTION

An armored patrol flushes snipers at Bining, France. Dec. 1944.

PLASMA ON THE BEACH

Medics at work just beyond the Normandy surf. August, 1944.



TIME

is highly expendable for these twenty-one Nazis as they hear final statements in the Nuernberg trial.

CROSSROADS
and the Signal Corps

By Dr. H. A. Zahl, Lt. Col. W. L. Martin
and Dr. G. K. Green

Signal Corps Engineering Laboratories

WHEN Test Able's air-burst cascaded a billowing mushroom of water, radio-active debris, marine life and ship wreckage into the sky above Bikini lagoon, many months of detailed planning by Joint Army-Navy Task Force One had been consummated. The release of microcosmic force by the splitting of the uranium atom was the prologue to a new era in the techniques of warfare, perhaps the preface to a new historical epoch.

Operation Crossroads was an experiment on the grand scale, far beyond the limited scope of the most progressive laboratory. It provided a mammoth test tube in which materials of war were exposed to the crucible of an atomic blast.

The Signal Corps was asked to participate in Crossroads by exposing representative equipments to the blast and by conducting experiments directly related to Corps functions. Additionally, Task Force communications were to be provided by Signal operational units.

I. Initial Planning

The active technical participation of the Signal Corps in Operation Crossroads was basically a problem for the Engineering and Technical Service and was executed by personnel of the Signal Corps Engineering Laboratories. The initial conference, with representatives of the War and Navy Departments, was held on 28 January 1946 and was a preliminary introduction to the general mission. The conference established interim procedures, and liaison offices and outlined the immediate requirement for detailed plans by participating arms and services. With appointment of a project officer, SCEL entered actively into Operation Crossroads and established an office in the Bureau of Ships, Navy Department.

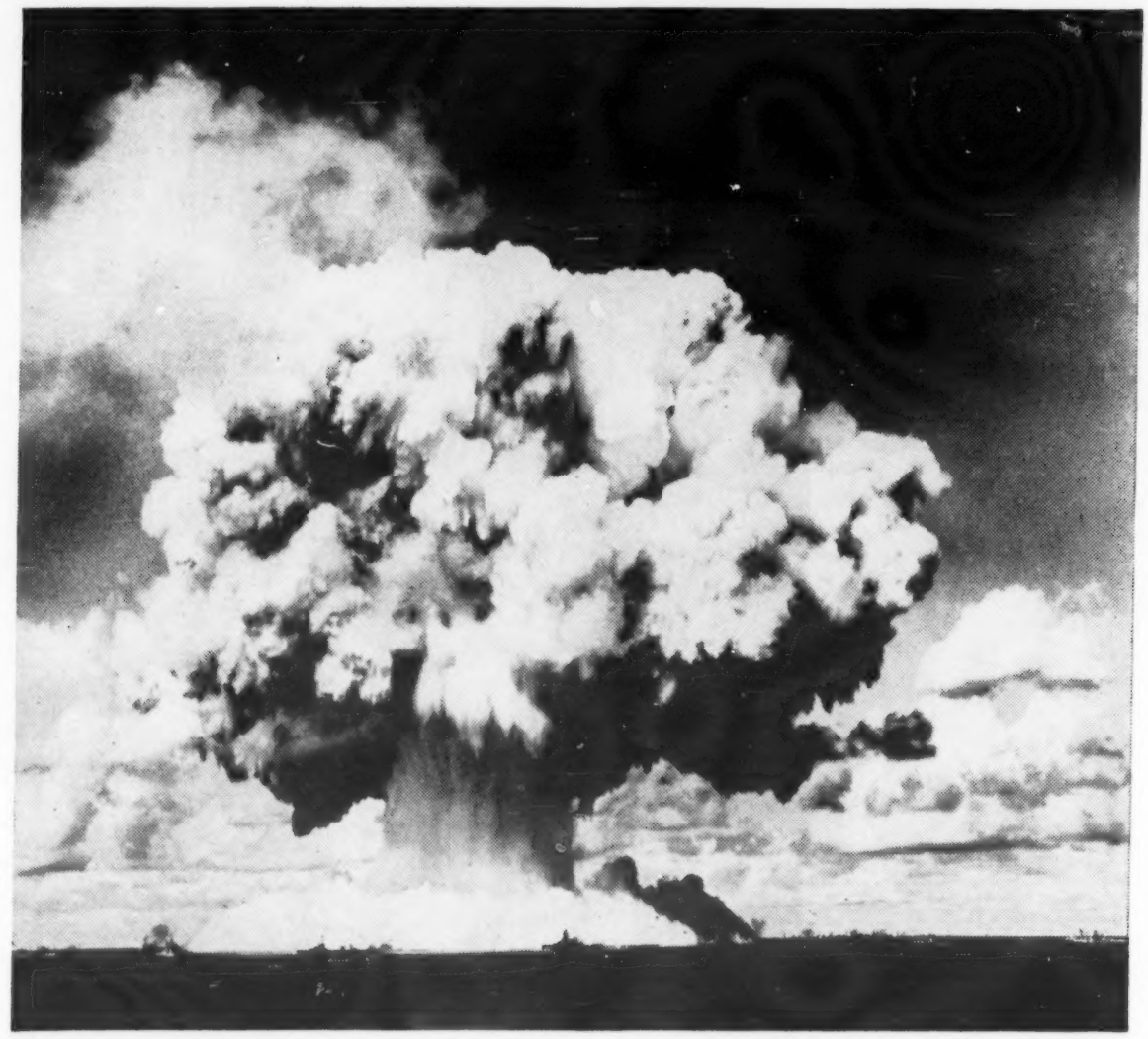
The Signal plan of operation resolved into three main categories:

a. Equipment Selection
b. Personnel Requirements
c. Logistics

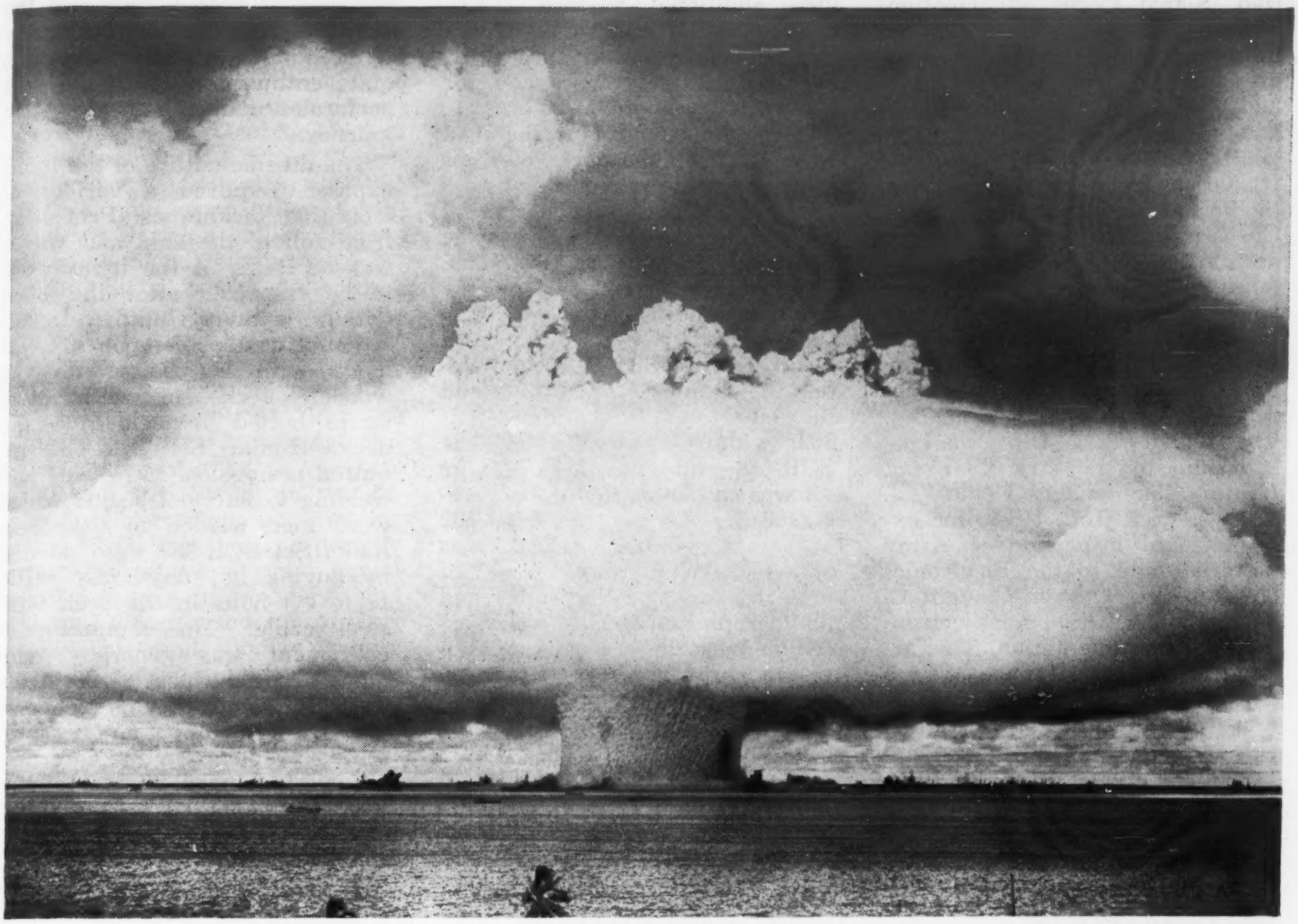
Equipment Selection: Coordinating conferences were held with staff representatives of AGF, ASF and AAF regarding selection of common types of Signal Corps equipment which the Army was interested in testing. The original list included over thirty items, representative of radar, radio, wire communications, sound ranging sets, cryptographic equipment, quartz crystals and various bulk items of photographic supplies. The finally selected and approved list covered eighteen items which were normally issued to AGF and AAF commands during the war. A few special items, largely radar, were included at the request of the Navy to establish permanent recording data facilities at Bikini Atoll.

Discussions were held with AGF representatives to ascertain the target vessels upon which the equipment was to be installed and exposed. Selection was based upon the distance of the target vessels from the center of the array, or aiming point. Commensurate with vessel selection, the number of items were grouped into main and secondary categories. Main items consisted of equipment such as SCR-584 radar sets which, by physical nature, were expected to survive the blasts. Secondary items consisted of equipment which would probably require replacement as a result of integrated blast effect, direct or indirect. Items in the second category constituted the bulk of the equipment.

Personnel: Efforts were made to secure key engineering personnel with suitable training and experience to form the cadre for the Signal Corps echelon. Additional operating personnel were requisitioned from the Com-



Another view of BAKER's eruption. The mountain of water is just beginning to fall back onto the target fleet, which has not yet felt the impact.



First phase of Test BAKER. History hangs in abeyance with this gargantuan mushroom of atomic debris.

manding General, Army Ground Forces. The final overall personnel roster assigned to Army Group 1.4, JTF-1, consisted of eight officers from the Signal Corps Engineering Laboratories and subordinate units, sixteen qualified civilian engineers and high level technicians and eight enlisted specialists, all from SCEL. Twenty specialists were assigned from domestic units or installations under AGF.

During the preparatory period the personnel were assigned tasks commensurate with their skills. The SCEL engineers fabricated non-standard test equipment; military teams of officers and enlisted men were assigned to various target vessels at ports to expedite and release equipment shipments and install such items as radar sets on vessels where fixtures for deck mountings were available. Among the interim work performed was the fabrication of recording equipment by the engineering staff and the installation of an SCR-584 on the U.S.S. *Prinz Eugen* for navigational purposes. This equipment replaced the inoperative German radar units on the ship.

Logistics: This phase of the Signal Corps participation was the most difficult to plan and execute. The movement of personnel and equipment on schedule for such an expedition required accurate timing and constant follow-up to ensure protection of the mission. The preparation and movement of the vessels involved many problems for the Navy, which were reflected by the participating arms and services altering loading plans and departure schedules of personnel.

Daily contact was maintained with *BuShips,* which had the intricate task of selecting and coordinating vessels for the tests. Fortunately, no signal equipment was loaded on ships eliminated from the Operation. Loading status reports on a weekly and an emergency basis were received from SCEL representatives aboard target vessels.

The mission assigned the Signal Corps was firmly established on a sound supply plan. All vessels departed from designated ports with the complete supply tables as computed by participating personnel. Later reports indicated that many service demands for internal communications within Army Group 1.4, and the fabrication of emergency electronic measuring equipment for other services, were met from the supplies taken by the SCEL contingent.

II. Technical Program

Joint Task Force One scientific and technical staff was roughly divided into two groups to examine and determine the effects. One group was responsible for display, testing and inspection of the large array of target material. The other unit was responsible for instrumentation to measure pressure, temperature, radiation, radio-activity and other physical phenomena and biological effects. Necessarily, the two functions overlapped and several groups and task units operated in both phases. The Signal Corps technical unit was one of these latter.

When JTF-1 was being organ-

ized, Signal Corps participation was requested, shortly after the initial planning stages. A background for technical planning had been provided by discussions among Col. J. D. O'Connell, Col. W. L. Martin, Dr. H. A. Zahl, Dr. G. K. Green and others, prior to formal entry of the Signal Corps into JTF-1. With this preparation, a rapid round of conferences in Washington laid the basis for the Laboratory engineers to contribute ideas, after which the Signal personnel for Crossroads were selected and detailed working plans prepared. The Signal Task Unit was responsible to the Army Ground Group Commander, Colonel J. D. Frederick, Inf., USA, for exposure and inspection of Army material; and to the Electronics Coordinating Officer, Captain C. L. Engleman, USN, for electronics and instrumentation. This arrangement worked smoothly since the two phases were separable and centralized technical direction of the Signal unit was maintained. Combination of the functions in a single unit allowed technical personnel to be used with facility for both material inspection and instrumentation. Forty-seven members of the Signal unit handled seven target installations and eight instrumentation projects.

The Signal Corps engineering staff sailed on the U.S.S. *Avery Island* from Oakland on 6 May. The *Avery Island,* an electronics repair ship, was modified to provide additional passage space, and to install electronic instrumentation. It served as a floating barracks and workshop for almost four months.

Target material for the test was placed on the decks of ships lying at a wide range of distances from the explosion. The initial problem was selection of the items for exposure to the bomb. Wire equipment ranged from the familiar Field Telephone EE-8 to Carrier Relay CF-3. Radio items included the SCR-536 "handie-talkie," Radio Set SCR-694, and the large mobile station, SCR-399, with its power unit. The SCR-584 anti-aircraft gun-laying set was chosen as the most representative radar and one SCR-682 harbor surveillance radar was installed. Numerous chests of batteries, quartz crystals and photographic material were assembled by the respective Laboratory branches for exposure. Precision instruments were provided by the Sound Ranging Equipment Unit.

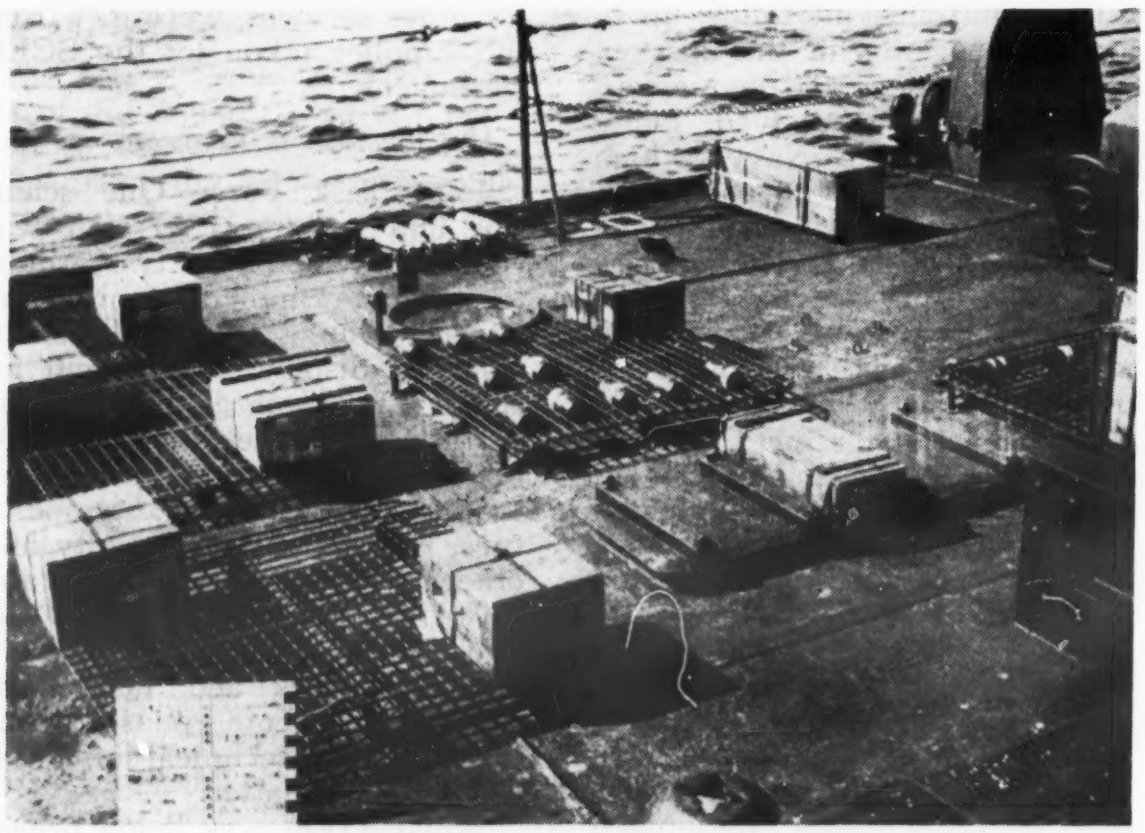
Of the several installations of radar SCR-584, one was mounted on the navigation bridge of the ex-German Cruiser *Prinz Eugen.* This set, in addition to exposure during both explosions, was used for navigation from Philadelphia, through the Panama Canal, to Bikini. Probably no other SCR-584, even during the war, was ever given comparable sea-duty. The *Prinz Eugen* had been seized with early German radar equipment, some of which had been removed at Philadelphia and the remaining unit was inferior by U. S. standards. The Navy was quite enthusiastic about the set's performance during the long sea journey.

The diverse nature of the items exposed required a variety of mounting techniques. Protection from roll of the ship and waves was necessary if the items were to be inspected after the blast without a diver's outfit. Installation of smaller components was made with lag bolts into the wooden decks or with steel straps bolted or welded to the deck. Radar Set SCR-584 required removal of its wheels and welding to lateral I-beams which were then welded to the deck. Radio Set SCR-399 was fastened by guying its "dog-house" HO-17 to eye-bolts in the deck with steel cable. The mounting of equipment was generally adequate and held most of the items securely enough for recovery. However, the mounting presented problems to the interpretation of damage. Signal equipment was exposed on the decks of target ships spaced from the center of the target area out to the edge, and damage ranged from total loss to negligible, as was desired.

The target material was installed, tested, operated and inspected by small Signal Corps parties on the ships. These groups sailed on the target ships and lived on board until the tests, when they were transferred to APA's used as hotel ships. After each explosion they returned to the target ships as soon as they were safe and prepared the material for inspection, return and salvage.

Inspection and testing of damaged equipment was supervised by the group of civilian engineers on the U.S.S. *Avery Island.* Dr. R. A. Weiss, physicist, from Evans Signal Laboratory, supervised the sound ranging equipment and was concerned with general physical measurements. Radar was under Hans E. Insler-man, radio engineer, from Evans Signal Laboratory. Wire communications equipment was under surveillance of Milton A. Lipton, electrical engineer from Coles Laboratory. Two radio engineers from Coles, Jacob H. Eggert and Amory H. Waite, Jr., handled radio gear. Paul J. Brooks, Maintenance Division,

AGF equipment prepared for exposure to air burst. Signal Corps material was placed at varying ranges from the target ship.



operated separately on the U.S.S. *Gasconade*, observing the maintenance aspects of the Signal equipment. Shock measurements were made by George Mackas, Fort Monmouth (Squier) Signal Labortory, who installed a system of shock and strain gauges to extend his work on ballistic impact effect on Signal equipment.

The Signal unit gathered a large amount of damage data from Test ABLE, the air burst. Analysis is complicated by the difference in exposure from normal Army conditions, but the data are applicable to any situation in terms of blast, pressure and heat. As usual in an explosion, the effects of shielding were very marked, especially when protection of small equipment was provided by large and massive superstructures or turrets. This and similar factors must be considered when making interpretations.

Although Test ABLE provided typical conditions for exposure of Signal equipment to the explosion, the underwater blast, Test BAKER, did not represent conditions remotely comparable to Army field experience. The submarine explosion produced a severe shock wave which was propagated through the water and struck the ships a tremendous blow. A few carefully selected items of Signal material were placed in close-in ships to use this shock wave as a giant impact-machine on equipment too large and complex for standard laboratory examination. Unfortunately, two of the most interesting samples went down with the *Arkansas* and *Saratoga*.

Most laboratory studies, and especially the fundamental experiments, are conducted on simple structures or members. By this method an engineering analysis can be made, whereas in many tests involving complex components, sets, or structures the analysis is so complicated that it can only be approximated. Operation Crossroads gave the opportunity to expose very complex sets and components to shock and heat on a scale far beyond present laboratory facilities, and to observe the results.

However, observation and testing of target material damage is only one phase of the experiment, for this gives only the results of one situation, one type of bomb. In order to generalize and to predict the results of new situations, physical measurements of all the phenomena connected with the bomb explosion are necessary. Measurements of both time and distance functions were required and the scale of the experiment made the instrumentation very extensive. There was an inclination for some observers of Crossroads to expect rather magical effects and to be somewhat disappointed because everything was not completely wrecked. Careful inspection of the damage and data was very impressive, more so when consideration was given to the large areas of water upon which the power of the blast was dissipated.

A Navy patrol bomber recorded Test ABLE's towering cauliflower of deadly radio-active smoke. This photo was made several minutes after the blast.

The Signal Corps unit was engaged in eight instrumentation projects of varying magnitude. These projects were primarily radio and electronic and were integrated with the general program of the Electronics Coordinating Officer, and with the instrumentation of JTF-1 as controlled by the Technical Director.

Very widespread observation of aspects of terrestrial physics was made by SCEL engineers at remote observation points. John F. Dickson, radar engineer from Evans Signal Laboratory, supervised observations in Hawaii until after Test ABLE, then went to Bikini for additional instrumentation. Capt. B. D. Clifford, S.C., Jerome Kelliher and Alfred H. Brecknell were on Guam; Richard A. Smith and William G. Stone on Wake Island. Dr. Craig M. Crenshaw went to Nome, Alaska, and Kenneth C. Burger to San Francisco. All these men came from Evans Laboratory and carried their equipment to their stations.

On the *Avery Island* the Signal unit performed part of the electronic instrumentation undertaken locally at Bikini. Dr. Weiss provided for Test ABLE a specially designed and extremely fast-acting, photo-thermal detector for time measurement of the far infra-red radiation from the explosion. Radio-frequency radi-

The ex-German cruiser "Princze Eugen" at anchor in Bikini Lagoon. Note SCR-584 welded in position above bridge.

ation at the very low-frequency end was recorded by Mr. Insler-man with special amplifying and recording equipment. Francis W. Fisher, radar expert from Evans Laboratory, installed and operated the latest harbor surveillance set, Radar Set AN/MPG-1 on an island of the Atoll. This high-definition precision set took radar pictures, with automatic cameras, of the target array during the explosions to supplement data from optical cameras.

The most extensive electronic project of the Signal group developed on the spot. A small telemetering system for remote measurement of radioactive radiations was installed for ABLE day. This system was constructed enroute on board the *Avery Island* by modifying Radio Set SCR-694 transmitters and receivers. The need arose for extensive telemetering of radioactivity during the BAKER Test, when the very intense radiation would endanger personnel and reliable remote measurements were required.

A fourteen-channel telemetering system was designed and constructed for the BAKER Test. Most of the Signal unit was involved and the system was fabricated in two weeks. On-the-spot design was provided by pooling the experience of Messrs. Waite, Dickson, Fisher, Eggert and Lt. E. S. Maury, who lived under a tarpaulin on Bikini Island to supervise the work there. Part of the channels were SCR-694's, battery powered, and rebuilt so as to be almost unrecognizable. The other channels were modified Navy sonobuoys, of which two were moored in the water and the others were mounted on ships. The geiger counters and ionization chambers used to detect the activity also were modified to extend their operating life and to modulate the transmitters with a calibrated signal. Complete recordings of the radio-activity were obtained and the system was operated for several days. These radio-activity data were available to the Task Force before the "hot" part of the lagoon could be entered by monitoring personnel. The radioactive materials persisting from an atomic blast are a terrible weapon, perhaps as effective as the percussion damage. Medical and biological data from Crossroads will supplement the radiation observations in Japan. These data can have as much effect on equipment design as physical damage information.

Signal Corps radio communication equipment was widely used at Bikini. The Navy has Radio Set SCR-608 installed on most ships, and Radio Set SCR-610 was used in all the small boats. This small set is very useful in such service, unless too great range is required. Soon after the arrival of the Signal group, the need for internal communications arose and a Signal Corps net was soon in operation with eight stations at Bikini Atoll, using SCR-694's and two SCR-399's. This 'private' net operated every day and was of great value, since the units were widely separated. The Army Ground group comprised some twenty-five different units and a radio net was established for the Commanding Officer. Twenty-six SCR-300 "walkie-talkies" were used on this net and gave very effective coverage, even at ranges of several miles over sea-water.

III. Observations

Non-participating observers were selected by the various branches of the Army and Navy to view the atomic bomb tests and to study the resultant damage, with respect to the interests of each of the services represented. These observers had no assigned responsibility in the actual operations.

The first contingent of observers, including Dr. Harold A. Zahl and Colonel E. C. Gillette of the Signal Corps, left Washington by special train for Oakland, California, on 8 June. The observers boarded the U.S.S. *Blue Ridge* and sailed for Bikini via Hawaii and Kwajelein on 12 June. Col. T. T. Teague joined the party of Signal Corps observers at Honolulu.

In the trip to Bikini, the *Blue Ridge* was part of a convoy including the U.S.S. *Panamint* and the U.S.S. *Appalachian*. The *Blue Ridge* passengers were restricted to military and naval representatives, while the *Panamint* carried Congressmen, non-participating scientists, and foreign observers, with the *Appalachian* transporting members of the press.

The convoy reached Bikini on 29 June. Following arrival, Vice Admiral Blandy and members of his staff, including Maj. Gen. Kepner, Maj. Gen. McAulliffe, Rear Admiral Parsons and others visited the *Blue Ridge* and conducted a round-table discussion on plans for Test ABLE. Inspection trips were made to representative ships of the target array and each observer was given opportunity to study installations on the various ships of particular interest to the organization represented.

On the evening before Test ABLE the *Blue Ridge* left the lagoon and cruised in the waters around Bikini, filling all tanks with fresh water. The schedule was timed to allow arrival at the designated observation point shortly before MIKE hour. Full steam was maintained so the ship

could quickly alter its position should a wind change blow the atomic cloud off its predicted path. The blast was viewed at a range of approximately 17 miles through special goggles. Following the initial flash of light, the goggles were removed and the spectacle observed with the naked eye.

Approximately three hours after the explosion the ships carrying the observers moved into the up-current portion of Bikini lagoon and dropped anchor. Geiger counters maintained a continuous safety watch over the waters.

The Jap cruiser *Sakowa* sank in full view of the observing ships. In the afternoon a tour was made of the target area but no ships were boarded. Ship and equipment damage were inspected during the following two days. Vessels boarded included the U.S.S. *Pensacola, Saratoga, Prinz Eugen* and *Nevada.*

On 5 July, members of Vice Admiral Blandy's staff again visited the *Blue Ridge* and a critique was held on the results available on the air burst. The observers then returned to Kwajalein and split into two groups, one returning to the United States and the other remaining for the underwater Test BAKER. Enroute to Kwajalein a tour was made of a number of islands that figured prominently in the war. Ports of call were Majuro, Truk, Ponape and Guam.

On the morning of 23 July the *Blue Ridge* returned to Kwajalein and the observers were briefed on details of the BAKER explosion. Brig. Gen. Akin joined the Signal contingent at Kwajalein. Following the round-table discussion the observers sailed for Bikini and arrived in position on 25 July.

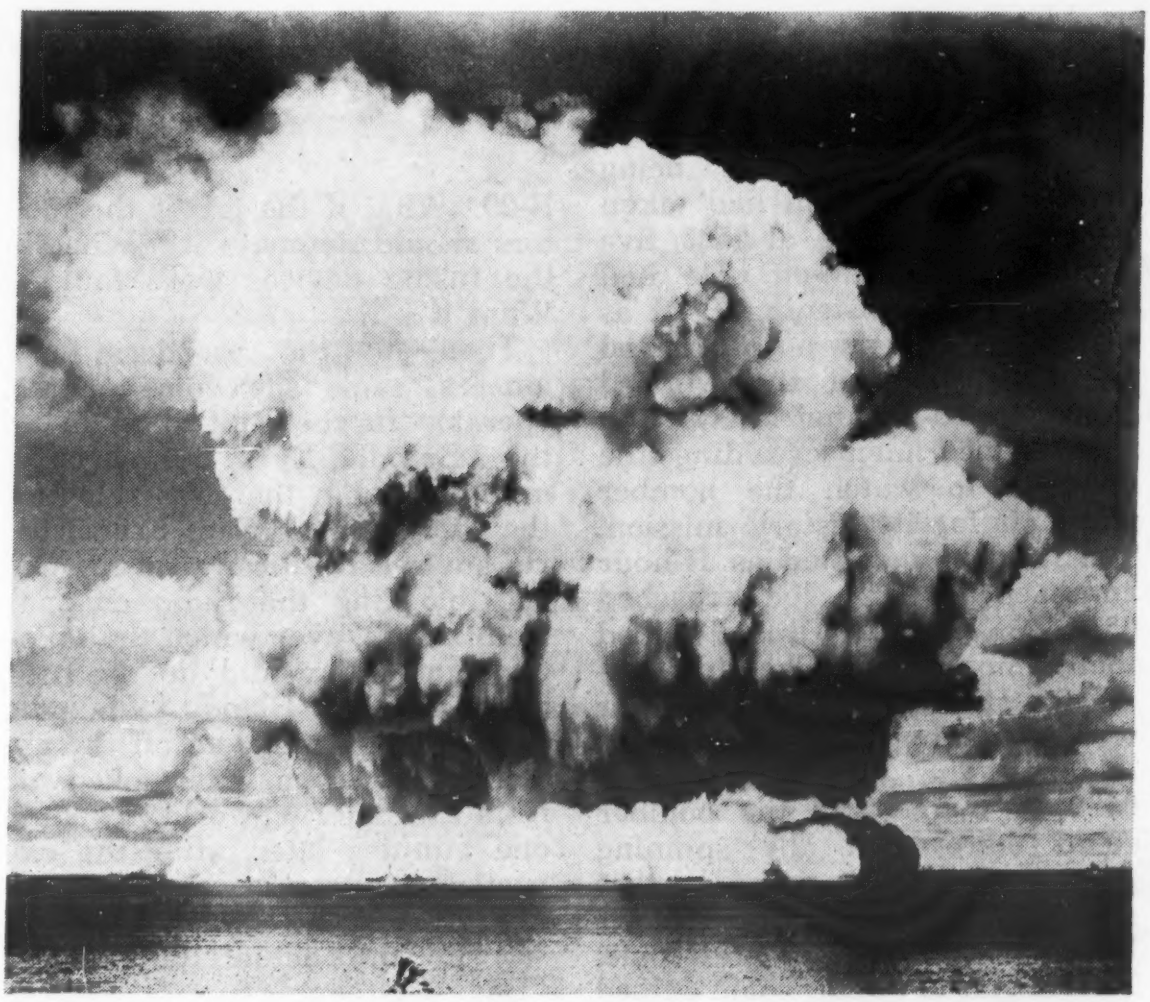
The underwater explosion was viewed without binoculars at a distance of approximately eight miles. There had been a feeling among the observers that Test ABLE could have been viewed from a closer range with comparative safety but there was no question of this sort on Test BAKER. In fact, had it been put to a vote, the observers would probably not have asked to be closer to the point of detonation by even the ship's length!

Dr. Zahl's reactions to the blast may be recorded in the following word picture . . . "At MIKE hour an awesome spectacle occurred when the waters of the lagoon arose like a giant asparagus tip. The central column of water expanded until it covered more than 2200 feet at the base with violent turbulence visible in the upper portion. The top of the column of water spread out in mushroom fashion and for a short time had the incredible appearance of hanging suspended in air. Then the million or more tons of water started falling as a great white curtain. As the descending cataract struck the remaining water of the lagoon, a great frothiness appeared, rising high above and engulfing the target vessels. A curtain of mist arose from the lagoon to meet the white wall cascading downward. The entire target array became enshrouded in the white, highly radio-active and dangerous fog. When the mist lifted some of the ships were missing and others were listing. Everyone who viewed this spectacle was forcefully aware that he had just witnessed the grandest, but yet the most horrible thing ever conceived by man."

Approximately one hour after the explosion the *Blue Ridge* moved toward the lagoon. At 4 P.M. everyone watched the sinking of the *Saratoga.* Anchor was dropped in the up-current part of the lagoon, which was free of radio-activity. On the 26th and 27th of July no inspections were made because of the highly radio-active condition of the target ships. All vessels in the lagoon carrying human beings kept up steam so as to permit immediate change in anchorage as the radio-activity map altered. On 27 July Vice Admiral Blandy and staff visited the *Blue Ridge* for a discussion of the underwater burst.

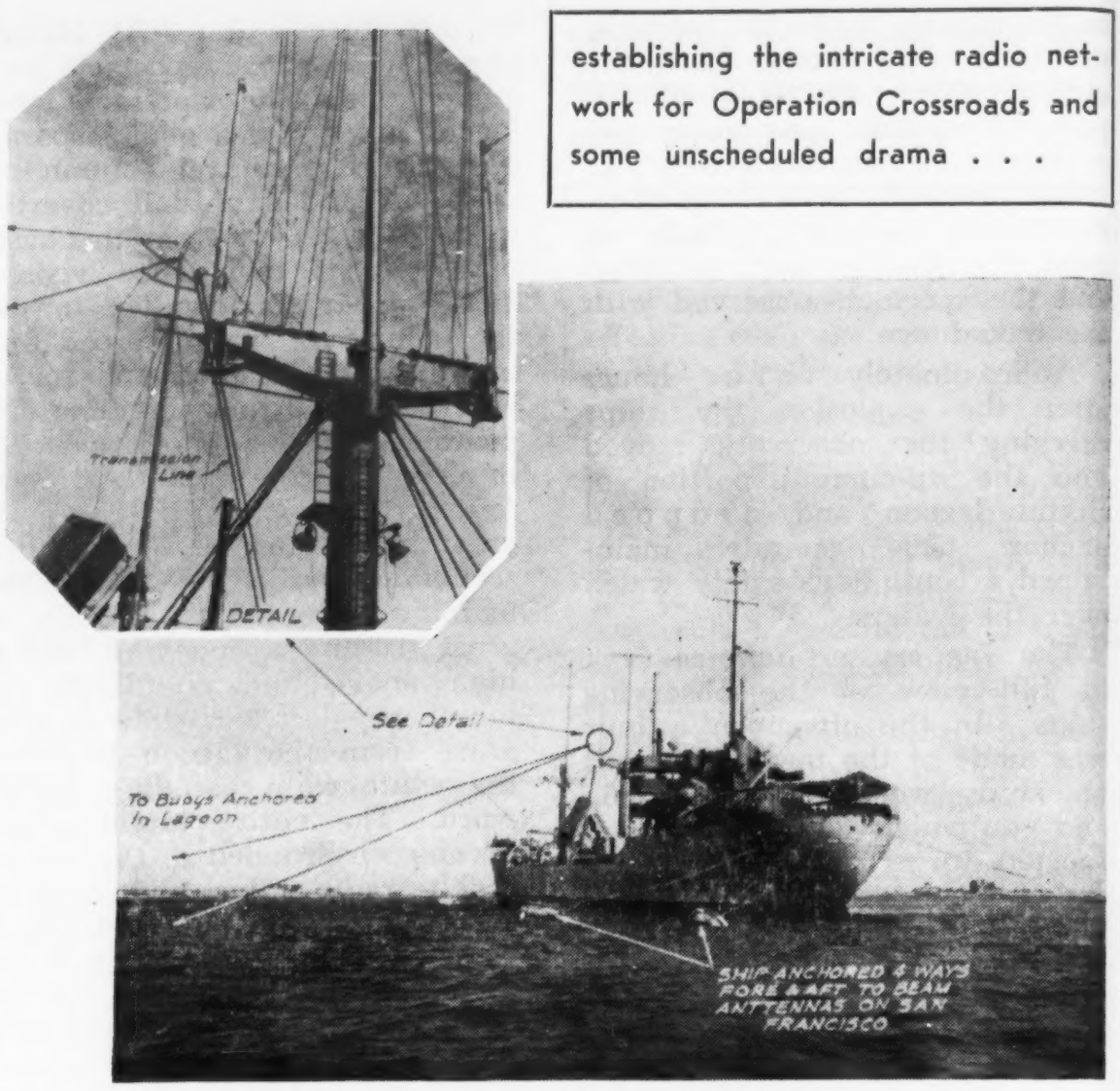
By 28 July the radio-activity in the lagoon had subsided to the extent that the ships could be visited, but not boarded. A large Navy tug was used so the observers could ride high above the yet dangerous waters. Only superficial inspection of external damage to the vessels and Bikini Island installations was possible.

Signal Corps participation in Operation Crossroads was highly satisfactory. Much information was gathered and analysis and interpretation are in progress. These reports will serve as guides in adapting Signal Corps equipment to atomic warfare.



Millions of tons of water are catapulted from Bikini Lagoon by the underwater explosion. Taken by automatic camera on the Atoll.

establishing the intricate radio network for Operation Crossroads and some unscheduled drama . . .



Signal Communications for the Bikini Tests

By Lt. Col. M. J. Luichinger, Signal Corps
Army Communications Service Staff Representative
Joint Task Force One

IT WAS A-Day, 1 July 1946. Through the combined radio networks the voice of Bill Chaplin, ace NBC commentator, was reporting the preparations for the take-off of "Dave's Dream," the B-29 that would carry the fourth atomic bomb from Kwajalein to its rendezvous at Bikini Lagoon. The surging rush of static and the staccato roar of four powerful motors mixed with the announcer's excited voice as he described the final warm-up and the pilot awaited the starting signal.

Across the world, millions of listeners edged closer to their radios, hung eagerly on every word. Then, without warning, Chaplin left the air. RCA, in San Francisco, frantically began calling NIGF, the Army communications ship at Kwajalein, from which the program was being transmitted. Repeated efforts to re-establish contact were futile. There was only an enigmatic silence.

Had there been a premature explosion of the bomb? Had Kwajalein been blasted into a shambles of atomic dust? Again and again the San Francisco control station called for Chaplin to come-in; there was nothing but a crackling static.

Meanwhile, far down in the South Pacific, at the southern end of Kwajalein Island, an unscheduled drama was being enacted. Bill Chaplin had taken the air, on schedule, at 0525, five minutes from take-off. He had described the glistening B-29 as it went through a protracted warm-up, pictured the worried and haggard ground crews and maintenance men crowding the run-way to watch the bomber move off for its historic mission. Tension had mounted as H-hour approached. The clock reached 0530 but "Dave's Dream" stood there, motionless. Chaplin, feeling the strain, began to grope for words, fighting the noise of the motors. The clock read 0531, 0532, 0533 and still the bomber stood there with idly spinning props. Everyone sensed that something was wrong. Hearts began to pound, faces grew pale. Men began to sweat; some cursed at the delay. There was that awful Thing in the belly of the B-29. What if the jar of the motors should detonate it? What if the fusing devices were faulty? What if . . .

Then, to the broadcast engineers, came the voice of the operator in the control room of the "Spindle Eye," Army communitions ship that was relaying the program to San Francisco. He advised frantically that NIGF was blocking the radio channel from Bikini, over which the take-off command would be received from Admiral Blandy. Immediately NIGF was taken off the air and Bill Chaplin was choked off from a wondering world. Twenty-one minutes later, after the expected command was received, he returned to the air and described the actual take-off of "Dave's Dream."

Test ABLE was a precision operation. Split-second timing was important but the weather was a controlling factor. The Commander of Joint Task Force One based his decision of execution on the weatherman's interpretation of meteorological data gathered from observers scattered throughout the Western Pacific. Analysis of observations made 24 hours prior to the tentatively scheduled take-off indicated conditions within the limits established as favorable. However, to guard against last minute deterioration in the overall weather in the Marshall Islands, the actual "go ahead" was to be a final word from Admiral Blandy, based on a final check made early in the morning of 1 July.

It was this command that would send "Dave's Dream" lurching down the runway. This was the command that could not be transmitted through a blocked

UMI

radio channel. During the early morning broadcast, 0300 on 1 July, covering the evacuation of unnecessary personnel from Kwajalein, a 7.5 kw transmitter was used on 13,970 kc., after which continuous contact was maintained with RCA in San Francisco, monitoring for the 0530 take-off show. As daylight approached, arrangements were made with RCA to bring up a 3 kw. transmitter on 18,530 kc., a good daylight frequency, with dual modulation on both channels, in case the 13 mc. transmissions should fade during the broadcast.

The Los Alamos group were guarding 2.3 mc., awaiting the all-important take-off signal but, because of the "Spindle Eye's," dual radiations, that channel was being badly heterodyned. Fortunately, the command had not been transmitted as scheduled because of last-minute doubt concerning cross-winds that had developed in the upper strata at Bikini. After a 21-minute delay, it was decided to proceed with the operation. Immediately following receipt of the order, Chaplin resumed his broadcast. Operation Crossroads was underway.

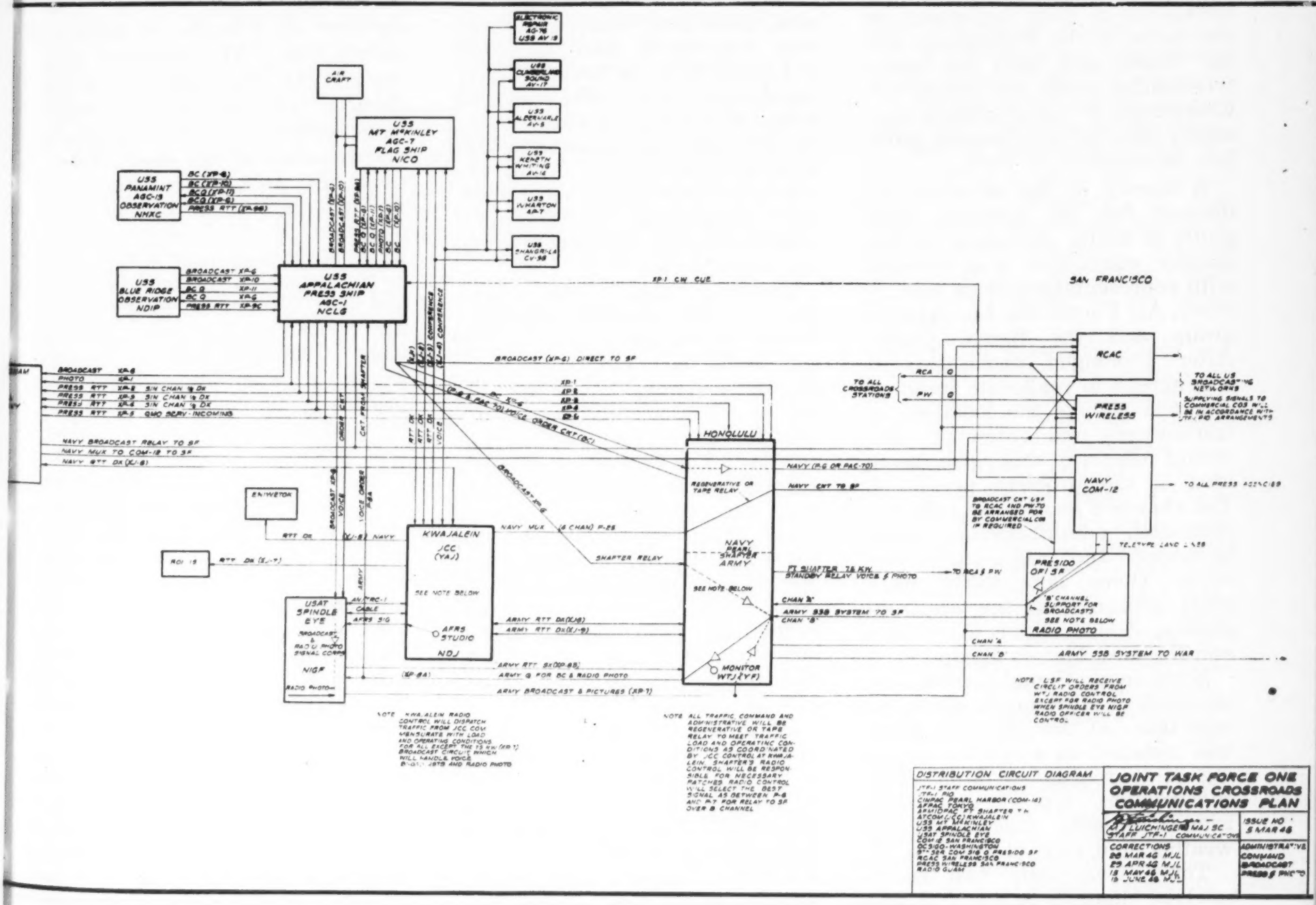
Early in February 1946 Army Communications Service had been asked to furnish certain phases of command and administrative communications, together with press, broadcast and radiophoto services. These activities were to center at Kwajalein Island.

ACS had in operation two single side-band, multi-channel radio-teletype systems from the Pentagon to Hawaii. One circuit was being relayed through the Presidio of San Francisco. It was thus necessary to provide reliable radio links from Ft. Shafter, Hawaii to Kwajalein, with subsidiary channels to Eniwetok and Bikini. Planning and requisition of equipment and personnel were completed before the unit left Washington.

It was decided to establish two main radio-teletype channels between Hawaii and Kwajalein, employing a 15 kw. Press-Wireless transmitter and RCA diversity receivers at Fort Shafter. Rhombic antennas were used on Oahu. The Kwajalein terminal included two Wilcox 2.5 kw. transmitters, with standard diversity receivers. Kwajalein was large enough to use rhombic antennas for reception but the transmitters, on nearby Carlson Island, were forced to use doublets. They were keyed from Kwajalein by VHF links.

The public information broadcasts were to be handled by the Army communications ship, "Spindle Eye," then in Tokyo Bay, where it was functioning under MacArthur's headquarters. The War Department arranged for the transfer of the ship to Kwajalein for Operation Crossroads.

The Signal Center at Fort Shafter, Hawaii, is a key relay point for traffic from Manila and Tokyo to WAR in Washington.



NOTE KWAJALEIN RADIO CONTROL WILL DISPATCH TRAFFIC FROM JCC COMMENSURATE WITH LOAD AND OPERATING CONDITIONS FOR ALL EXCEPT THE 15 KW (XP-7) BROADCAST CIRCUIT WHICH WILL HANDLE VOICE, B-C-I, JBTB AND RADIO PHOTO

NOTE ALL TRAFFIC COMMAND AND ADMINISTRATIVE WILL BE REGENERATIVE OR TAPE RELAY TO MEET TRAFFIC LOAD AND OPERATING CONDITIONS AS COORDINATED BY JCC CONTROL AT KWAJALEIN. SHAFTER'S RADIO CONTROL WILL BE RESPONSIBLE FOR NECESSARY PATCHES. RADIO CONTROL WILL SELECT THE BEST SIGNAL AS BETWEEN P-6 AND P-7 FOR RELAY TO SF OVER B CHANNEL

NOTE LSF WILL RECEIVE CIRCUIT ORDERS FROM WT. RADIO CONTROL EXCEPT FOR RADIO PHOTO WHEN SPINDLE EYE NIGF RADIO OFFICER WILL BE CONTROL

DISTRIBUTION CIRCUIT DIAGRAM

JTF-1 STAFF COMMUNICATIONS
JTF-1 RIO
CINPAC PEARL HARBOR (COM-14)
AFPAC TOKYO
ARMIDIVAC FT SHAFTER T.H.
ATCOM (CG) KWAJALEIN
USS MT MCKINLEY
USS APPALACHIAN
USAT SPINDLE EYE
COM 13 SAN FRANCISCO
OCSIGO-WASHINGTON
9TH SERV COM SIG O PRESIDO SF
RCAC SAN FRANCISCO
PRESS WIRELESS SAN FRANCISCO
RADIO GUAM

JOINT TASK FORCE ONE OPERATIONS CROSSROADS COMMUNICATIONS PLAN

C. F. LUICMINGER MAJ SC
STAFF JTF-1 COMMUNICATIONS

ISSUE NO 1 5 MAR 46

CORRECTIONS
28 MAR 46 MJL
29 APR 46 MJL
18 MAY 46 MJL
15 JUNE 46 MJL

ADMINISTRATIVE
COMMAND
BROADCAST
PRESS & PHOTO

Communications for Operation Crossroads was a coordinated project. This chart outlines the over-all plan.

In order to facilitate the necessary circuits for direct Kwajalein-Washington communications, arrangements were made to clear two channels of the Shafter-San Francisco system. This move required coordination to prevent overloading the Philippine and Japan circuits.

At Kwajalein very bad radio interference problems were immediately encountered. Some 300 frequencies were involved, with 40 to 50 transmitters on the air simultaneously in a very confined area. Power ranged from 100 watts to 7.5 kw. and all types of emission were used, with resultant spurious radiations, harmonics and heterodynes. Interference was even experienced up to 110 mc., disturbing all VHF keying and control circuits.

Crossroads communications were not disturbed at that stage but it was a serious matter to AACS, who were handling all airways traffic, navigational aids, meteorological data, plane dispatching and passenger manifests. Further, the Naval Air Station at Kwajalein is very important on the route to the Philippines and the Orient and, with the heavy terminating traffic associated with Crossroads, it was absolutely necessary that the interference problem be resolved at once.

A survey of the situation indicated that all agencies were guilty of faulty operation. A frequency committee was formed, with representatives from AACS, Navy, Air Forces, the Los Alamos group and the Signal Corps. After prolonged discussions it was agreed to reallocate frequencies and change the locations of transmitters and antennas. The circuit diagram will give some idea of the problem presented. The channels shown are only the command, administrative, press, broadcast and radio-photo circuits. There were many other units operating in the area, including AACS, Navy, Air Force and the Los Alamos groups.

Kwajalein's Signal Center, the terminus of all radio channels except those of the "Spindle Eye," was installed in a special grouping of four Quonset huts. This construction, typical of Pacific island projects, was ideal for weather and ease of erection.

There were only two radio-teletype channels to the U. S. and it was imperative that they be

Joint communication center. Kwajalein Island.

engineered for the greatest possible efficiency. Semi-automatic teletype AN/TGC-1 units were used, providing automatic message numbering and recording and facilitating the constant feeding of tape. There were the usual array of teletype machines, No. 15, 19 and the associated 131 table and No. 14 transmitter distributors. All of the most modern equipment, cryptographic units and secret conference facilities were in use.

The two channels from Kwajalein provided excellent efficiency. Reception channels were 13,810 and 13,860 kc., and transmitting frequencies were 14,020 and 14,080 kc. The circuits were available for an average of 21 hours per day. The frequency changes, normally expected between night and day transmissions, were never required throughout the entire operation. The daily transmitting capacity was over 150,000 groups, which was never taxed to the limit. Peak load, on A-Day, including press and administrative traffic, reached only about 65% of capacity.

Unorthodox methods had to be utilized in beaming a strong signal from the ship, "Spindle Eye," to the commercial outlets in San Francisco. The vessel was anchored about ¼-mile off shore in Kwajalein Lagoon, with the traditional single bow anchor permitting her to lay with the prevailing wind. Normally West by South at that season in the Marshalls, these winds set the "Spindle Eye" on a course of approximately 250°. The standard ship antenna, in this case a delta-fed doublet, propagates two major lobes broadside to the longitudinal direction of the wire. Effectively this produces a strong lobe at right angles to the antenna direction. In this case the signals were being beamed at about 160°, or Southeast, in the one direction and 340°, Northwest, in the other. The true great circle bearing from Kwajalein Lagoon to San Francisco was 53°, which was practically at right angles to the orientation allowed by the Marshall winds.

Both RCA and Press Wireless, in California, were complaining about weak signals from the communications ship. A level at least 25 db. above noise is required to deliver a commercial signal to the broadcast networks. Performance of that caliber required proper antenna orientation and the use of a beam for transmissions.

Shifting the signal pattern some 90° necessitated dragging the "Spindle Eye" into a position heading on a course of 143°, which put the prevailing winds broadside against the port and required a special series of anchors fore and aft to hold her in posi-

tion. This was contrary to standard practice and after some opposition the Navy assisted in accomplishing the objective.

RCA and Press Wireless immediately reported that the signal had been stabilized. This result encouraged further experiments to improve the signal strength in San Francisco. With the ship in a stationary position the construction of an inverted-V antenna was suggested. With the generous aid of the Naval Port Director at Kwajalein special buoys were placed in the Lagoon and a standard land-based antenna was constructed over the water, with the apex of the V atop the midmast of the "Spindle Eye."

Other ships anchored in the lagoon began to complain to the Port Director that the high tension wires were difficult to see at night and presented a handicap to small-boat navigation. It was requested that suitable markers be placed on the antenna wires. Long red rag streamers were used for day-time marking and 40-watt fluorescent tubes for night identification. These tubes resembled low-hanging rectangular moons shining in the black of night and were very effective in steering boat traffic clear of the antennas.

The use of the V-antenna improved the signal strength by 30% and enabled the "Spindle Eye" to transmit merit four and five signals into RCA and Press Wireless. In the parlance of the broadcaster, that is tops.

Providing communications for Operation Crossroads was a particularly trying task because it came in the midst of demobilization. Somehow, with the fine cooperation of occupational units, the necessary personnel were provided. Twenty-five officers and 78 enlisted men were assigned to the project.

Signal, Air Force and Navy communications personnel worked very hard on Crossroads under most difficult conditions. Each service performed in an outstanding manner. It can be summarized in the words of Navy Secretary Forrestal's special message to Admiral Blandy: "Congratulations on a job well done."

QUARTZ CRYSTALS AND THE WAR

FROM official records in the Office of the Chief Signal Officer comes one of the most unusual mass production stories of the war.

It tells of the virtual creation of a quartz crystal industry which immediately became an indispensable element in the radio communications of America's war machine.

Tiny wafers of quartz crystals, finished to within a ten-millionth of an inch, were the products of this industry and their vital purpose was to keep radio transmitters and receivers tuned to their assigned frequencies. These crystals made it possible for the Army to use thousands of frequency channels with complete dependability, and enabled commanders to achieve coordinated use of air, mechanized and infantry units.

Production, by the millions, of these precise units in a quality suitable for hard military service under all conditions of climate was the result of close collaboration in research and development between the U. S. Signal Corps and the scientists and engineers of the electrical industry.

Not many years ago these crystal wafers were little more than a laboratory curiosity and even in 1941 only 100,000 units were produced by a few scattered manufacturers, mainly for use by commercial broadcasting stations, police radio systems, amateur operators and by the Signal Corps.

Some 50 different grades of quartz were being imported, almost exclusively from Brazil. No uniform standard of raw quartz or the finished product existed. There were almost as many processes and standards as there were producers, whose output included more than 250 varieties in differing sizes, shapes and mountings.

There were no adequate techniques for finishing crystals in large quantities and there were few skilled technicians or production engineers in the field.

This was the gloomy situation which confronted the Signal Corps when, as the procurement and development agency, it estimated that the military requirements for the first year of the war would be in excess of 6,000,000 units, with some of the thousands of radio sets requiring as many as 120 crystals.

A development program which had been under continuous study by Signal Corps engineers was at once initiated which, before its completion, enabled a single firm to equal in one week the combined annual pre-war production of the entire industry.

A Quartz Crystal Coordination Section, staffed by outstanding authorities, was set up. Among other immediate steps was the establishment of a pool of production equipment, the initiation of inspection procedures, the provision of financial aid to manufacturers, and the formulation of a training program.

The manufacturers — new and old—pooled their resources, exchanged information and a standardized program of production was developed which made possible the use of smaller crystals and lower grade quartz, which could be more readily obtained. The Signal Corps set up several inspection stations to facilitate the flow of quartz and established training schools for crystal cutters and finishers. It was found that women were suited to perform the complex, precise manufacturing operations and they were employed in large numbers.

While the 6,000,000 units required for 1942 were produced, the subquent demands were increasing with startling speeds. It was necessary to produce 21,000,000 in 1943 and by 1945 a rate of 36,000,000 units a year was attained. At the peak, 134 plants—working 24 hours a day and 7 days a week—were engaged in manufacture and the unit cost had been reduced to one-fourth of its 1941 figure. The results of the program have been described as "one of the outstanding syntheses of science, technology and industry in the service of the Nation."

For use in the field, the Signal Corps designed and installed equipment for testing, finishing and maintaining crystal units and sent crystal grinding teams to overseas theaters.

SIGNAL CORPS TRAINING IN THE AAF

story of the Aircraft Warning Unit Training Center at Drew Field

ALONG with the atomic bomb and the v.t. artillery fuse, radar is in the top trilogy of World War II weapons. The use of pulse radiation to locate enemy raiders was a strong factor in neutralizing mass bombing attacks and in achieving aerial supremacy in every theater of war.

Army Air Force pilots, bombardiers, navigators, gunners and their ground crews, were highly publicized because of the spectacular nature of their missions. No less important were the other members of the AAF team—those men who performed tasks of such secrecy that they often served in virtual oblivion. Typical of these were the Signal Corps units assigned to the Air Forces. They installed and operated the highly complex ground radar equipment and the globe girdling communications systems of the air arm, and numbered at one time more than 80,000 officers and men.

Radar was the first of the new developments that heralded the technological age in warfare. During the early 1930's radar, experiment and research were carried on by relatively few engineers and technicians and the advent of war created a demand for skilled operators and mechanics that could not be met from exisitng manpower sources.

The training of both personnel and units for aircraft warning operations presented a difficult task, one for which there was no precedent. The Air Forces, in cooperation with the Signal Corps, undertook the development and procuring of equipment and the training of personnel on a scale hardly conceivable in December, 1941. Largest of these AAF training centers was the Aircraft Warning Unit Training Center, which prepared all Air Forces ground radar units for the field. It operated under the supervision and direction of the Commanding General, Third Air Force, at Drew Field, Tampa, Florida, and

A fixed-station training site. There were 20 of these in Florida alone.

reached a peak of 32,500 staff and troops in mid-1943. Two other training centers for Signal Corps troops were operated by AAF during the war: The Western Signal Aviation Unit Training Center at Pinedale, California, and the Eastern Signal Aviation Unit Training Center at Langley Field, Virginia.

Radar must depend ultimately upon the efficiency and accuracy of its operators, as is true of any technical device. Intelligence, native skill and thorough training were requisite if the maximum were to be derived from this new weapon. Experimentation and development had been tremendously accelerated during the years immediately preceding the war but the need for military security was such that radar was something of an esoteric science. Yet, the urgent and immediate demands of war imposed the herculean task of procuring and training thousands of skilled operators and mechanics almost overnight.

The earliest Army training in radar techniques was informal and was a function of the Signal Corps Laboratories. It was largely effected by exposing detachments of antiaircraft troops to the development work being performed at Fort Monmouth. A course on Radio Set SCR-268 for Coast Artillery non-commissioned officers was conducted at Fort Hancock in 1940. These men later formed the cadre for an antiaircraft artillery radar school.

Special training in ultra-high frequency techniques associated with radar was given selected Army and Navy officers at Harvard University and Massachusetts Institute of Technology, beginning in June, 1941. These institutions provided the most advanced electronic training facilities and furnished the armed forces with a nucleus of trained officer personnel.

First steps in formal training of Signal Corps troops was the formation of an Aircraft Warning Department of the Signal Corps School in June, 1941. By early 1942 this school was operating on a three-shift basis, training radar operators and mechanics.

Expansion at Fort Monmouth and the need for larger facilities led to the opening of Camp Murphy at Hobe Sound, Florida, in June, 1942. This installation was named for Colonel William Murphy, long associated with engineering developments in the Signal Corps, and who was killed in the South Pacific. It housed the Signal Corps Radar School, later renamed the Southern Signal Corps School. For the ensuing two years Camp Murphy produced thousands of skilled technicians, including enlisted men and officers of the Signal Corps, Coast Artillery, Air Corps and Marine Corps, and a limited number of Allied Army officers. Most of the graduates of Camp Murphy were sent to Drew Field for unit integration and training.

The III Interceptor Command at Drew Field was in the process of planning an Aircraft Warning School for the Air Forces when Japan struck at Pearl Harbor. The project was immediately accelerated and 100 officers and 1700 enlisted men were transferred from Camp Wheeler.

These men and the personnel of the 530th Signal Co., AW, the 307th, 317th, 331st Signal Companies, Air Wing, and the Signal Hq. and Hq. Co., III Interceptor Command, served as the cadre of the III Interceptor Command AWS School at Drew Field.

A visit to the school by Lt. Gen. Somervell, Maj. Gen. Olmsted (then Chief Signal Officer), and Brig. Gen. Huebner in April 1942 resulted in a directive authorizing the III Interceptor Command to establish a training center, to train operating crews and mechanics, and to organize and prepare units for shipment. In June the "Aircraft Warning Service Unit Training Center" was formally established at Drew Field.

The immediate result was the monthly shipment of thousands of untrained men to the new school. In spite of hard work and intelligent effort by the then commanding officer, Colonel Benjamin Stern and his staff, progress was hampered by lack of equipment, housing, training facilities and a competent instructional staff. Nevertheless, many units were shipped from Drew Field during 1942.

The Training Center grew so rapidly that it became necessary to assign a general officer to the command. At the request of Lt. Gen. George E. Stratemeyer, Deputy Commander, Army Air Forces, and Maj. Gen. St. Clair Streett, Commanding General Third Air Force, Brig. Gen. S. H. Sherrill was released to the Air Forces from his command at the Western Signal Corps Training Center, Sacramento, California, in March, 1943, and transferred to Drew Field.

After an exhaustive study of the procedures and methods in effect at AWUTC, a plan for complete reorganization of the Training Center was prepared. In April, 1943, Generals Streett and Sherrill, accompanied by Lt. Col. David T. Griffin who worked out details for the plan, flew to Washington and presented the plan to AAF Headquarters.

The primary mission of the Aircraft Warning Unit Training Center, according to the Streett-Sherrill plan, was to be the organization, training, equipping and complete preparation of radar units for service in combat theaters. The secondary mission was the training and preparation of individual officers and enlisted men for assignment to units organized at the Center, or as replacements for combat theaters.

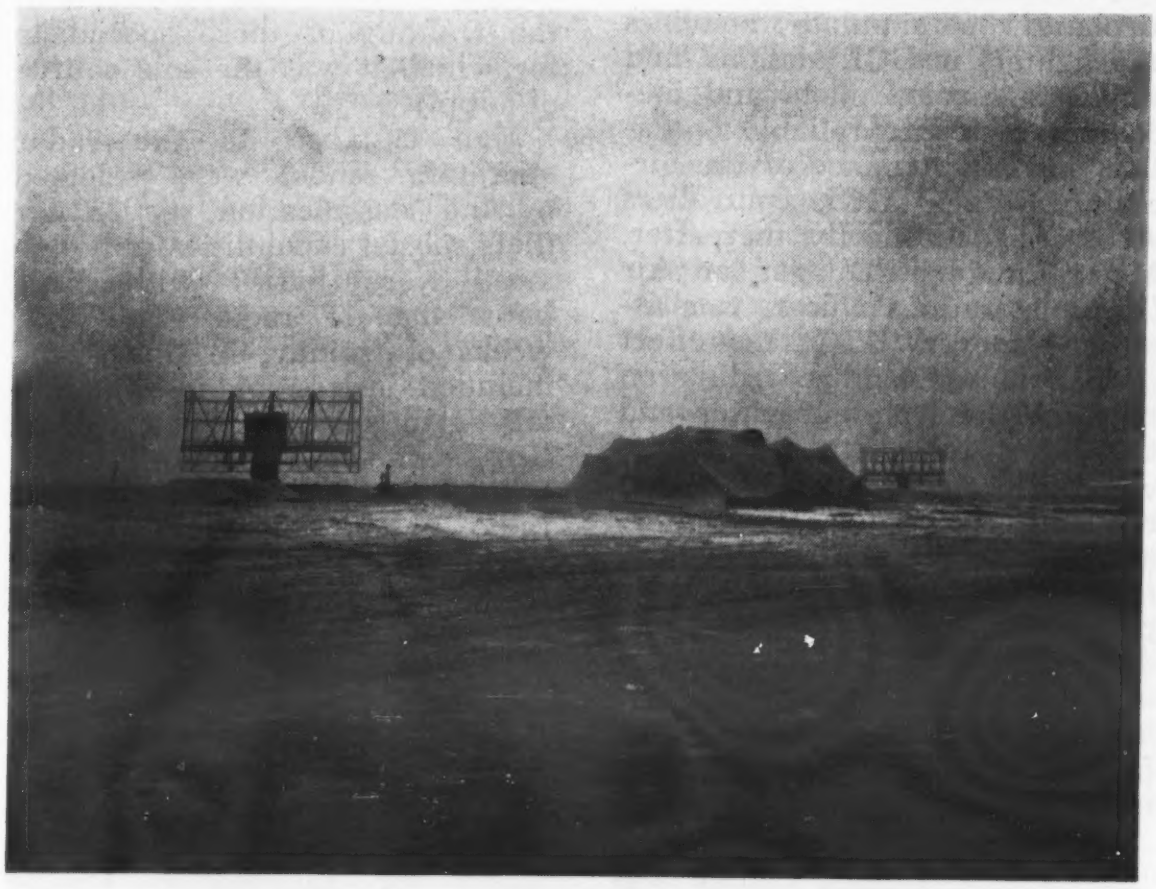
Certain recommendations of the plan were approved, in lieu of blanket acceptance. A "standard unit" was to be established as a guide in training. Instructional procedures were to be prescribed in phases. Production schedules were to be based on theater demands, coordinated with the procurement of new equipment. The use of the Operational Training Unit (OTU) system, then being employed for bomber crews, was authorized for AWUTC.

Under the new plan the "stage" system was eliminated and training battalions were established and their functions defined. An "Individual Training Group" was formed from the 501st Signal AW Regiment. The 1st Training Battalion of the Group received and processed all new men and provided their basic military and physical training. The 2nd Training Battalion was charged with specialist training, including AW filterers, AW operators specializing on type radar sets for early warning, the SCR-602 lightweight and MEW and GCI sets, Diesel engine mechanics, draftsmen, information center operators, portable power generator repairmen, powerhouse engineers, radio code operators. An officers' school was established for training commissioned specialists.

All tactical units were assigned to the 3rd, 4th, 5th and 6th Signal AW Training Battalions, which were charged with their organization, training, equipment and preparation for overseas movement. These battalions were delegated authority to transfer personnel among units under their control and to conduct such training as necessary to accomplish their missions.

The new training system eliminated the weaknesses of the stage system, although the OTU method was not used. Previously a unit was formed in one stage, trained in another, with consequent divided responsibility. After reorganization, the training battalion was responsible for the formation, training and complete preparation for overseas movement of all units under its jurisdiction. Further, the units in each battalion were of a standard form, operating a specific type of radar equipment. This method allowed a much more coordinated training effort.

Concurrently, AAF headquarters instituted a program to furnish AWUTC with specialists and personnel in an even flow. Approximately 6,000 enlisted men were to arrive at Drew Field in the first half of each month. Fifty per cent of these were fillers, already trained in Service Forces Schools; two thousand were to be



The SCR-527 GCI radar camouflaged in position on Tampa Bay.

trained at Drew in aircraft warning specialties and the remainder were basics.

As a further step in increasing the efficiency of the training center, officers of proven ability were assigned to key command and staff positions. Colonel Roland W. McNamee, a West Point graduate with wide experience, was transferred from Camp Kohler, California, and assigned as Executive Officer. Lt. Col. Kenneth F. March, another West Point graduate with an extensive military career, including the organization of the Aircraft Warning Service in Iceland in conjunction with the Royal Air Force, arrived at Drew Field in June and was assigned as S-1, Hq., AWUTC. Both of these officers made important contributions to the reorganization of the training center.

The previous scarcity of training equipment had been greatly alleviated by September. There was still an extreme shortage of SCR-602 sets and additional SCR-527 sets were needed but other type radar units were available and they could be substituted during portions of the training period.

During August the training center received sufficient aircraft and Air Corps personnel to enable it efficiently to train GCI (Ground Controlled Interception) crews. The AWUTC command was assigned three medium B-18 bombers for calibration and test missions, 28 attack-type A-24 airplanes to simulate bombers and fighters in GCI missions, and sufficient service pilots and mechanics to insure reliable operation and maintenance of the aircraft. Fifteen GCI controllers were assigned shortly thereafter. Major Lawrence Duggar, an Air Corps operations officer, was assigned to AWUTC to effect proper liaison and coordination between the training center and the bases to which the planes were allocated. Since the first requisite for GCI training is actual interception, this equipment enabled the command to perform effectively one of its major training missions. Interceptions increased from an average of only six per month in June for each GCI unit, to 45 per unit in September.

Effectiveness of the reorganization of the training center was indicated by the increased production of adequately trained aircraft warning units, more of which were shipped in August 1943 than in any previous month. This increase continued in September, when 12 fully trained companies and detachments departed. Personnel totalled 62 officers, 9 warrant officers and 1677 enlisted men. In comparison, three companies, 28 officers and 726 enlisted men were shipped in April 1943.

In September sweeping changes in training operations were initiated to organize and prepare nine new-type battalions to participate in the Normandy invasion. AWUTC, as then organized with the 1st Training Regt. under Col. James Van Ingen and the 2d Regiment under Col. R. N. Kunz, the 3rd under Lt. Col. Floyd and the 4th, 5th and 6th under Col. James McGraw, Col. Peter Shunk and Lt. Col. George Higginson, respectively and each specializing in certain type sets, was capable of solving the urgent new training problems.

Specialist Training

Until early 1943 the Aircraft Warning Unit Training Center attempted to train practically every specialist used by AW units. In April AAF directed that all specialists common to other branches would be supplied from ASF training centers. Although radio operators were later excepted because of the general shortage throughout the Army, the training center, after 1 May, concentrated its efforts in the training of those specialists for which it was the sole source of supply.

Men assigned to the radar operators school were selected by the classification section for their special capabilities, although most were basics with little knowledge of radar. The four weeks of training in this school included instruction in the military grid system, plotting practice, echo interpretation, orientation, the use of SOP's, and radio and telephone procedures. A change was made in the training of Information Center Operators, the United Nations System being taught exclusively for four weeks instead of the former combined American and English systems. Classes were being conducted on a day and night schedule to meet the demand for Information Center Operators. Filtering was still considered a secondary course to plotting and was taught to carefully selected members of the plotting groups. Special courses were provided for medical personnel to furnish aid men for the isolated AW units when they were in the field.

Unit Training

Operational training for units began with O-Day and was divided into three phases. The first 21 days were used to weld the unit into a military organization capable of defending itself against any type of attack. Training included camouflage, individual protection, use of weapons and defense against chemical, infantry, mechanized and airborne attacks. Any available time was used to acquaint the newly-formed teams with the equipment and to improve the skill of the individual specialists. To each radar platoon, information center team, and ground observer company was attached a supervisory cadre of seasoned personnel, practically all of whom had been through similar operational training or had experience with functioning units in overseas theaters or in defense commands. These supervisory teams did not relieve the unit commander of his responsibility of supervision and control but they were able to guide team performance, point out training deficiencies and how to correct them.

After the first three weeks of combat and limited operational training, the unit moved into the field, set up its radars, ground observer stations and information center and functioned for six weeks much as it would in a tactical situation. Section training was emphasized during the first two weeks of field operations, which were conducted at reduced distances for maximum supervision. Mobile platoons practiced the erection and packing of their equipment and rigid adherence to SOP's was enforced. Accuracy and speed resulted from continued practice during 24 hour operations. Ground Control Intercept units were assisted by a GCI Controller who oriented the platoon and trained the Plotter-Computers.

During the last four weeks of operational training, each unit conducted a field exercise at full distance. As a check on the efficiency of the unit, tracking missions were flown, and each radar

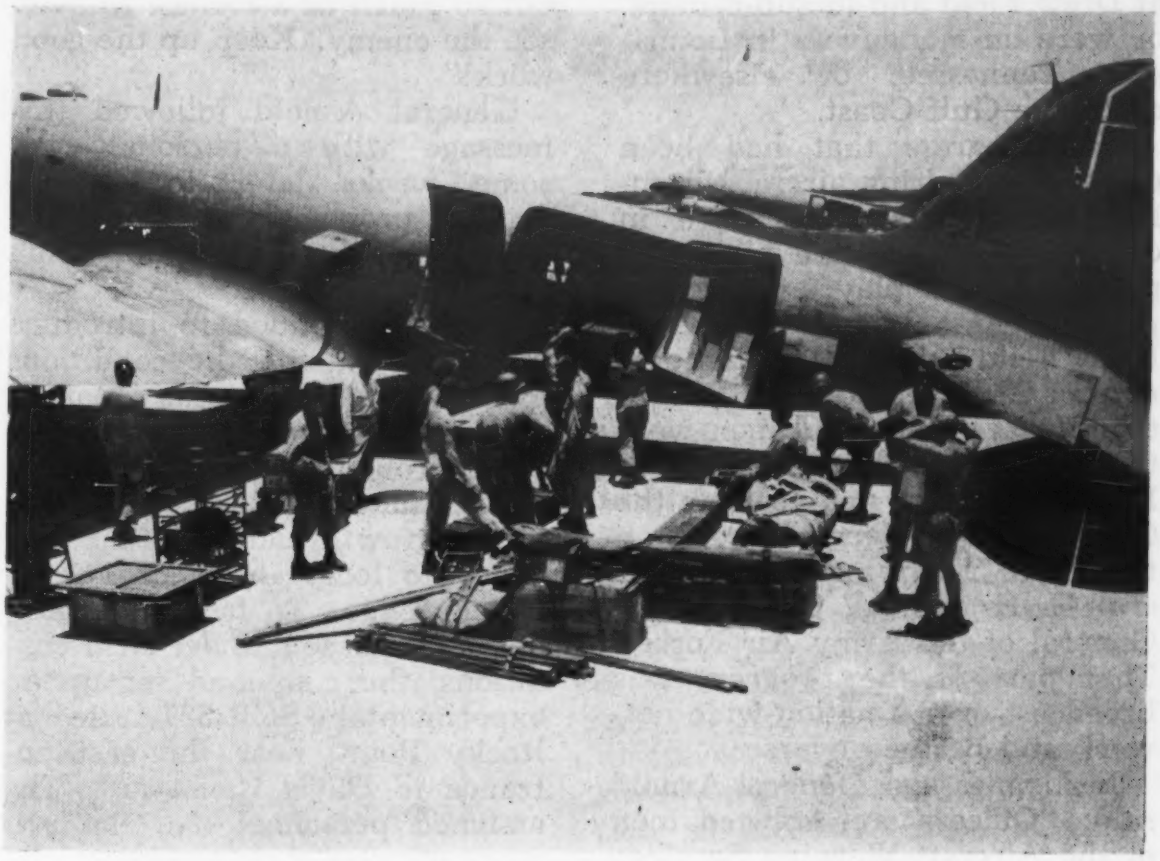
unit attempted to obtain a complete track on the plane. Aerial photographs were used as a check on defense plans and camouflage discipline. GCI platoons demonstrated their ability to perform interceptions with the assistance of controllers and training flights. Throughout the entire operational training period the supervisory team accompanied the unit. Their functions of guidance and advice were gradually reduced as the unit was able to increase its efficiency.

During the nine months from January to October 1943 the AWUTC trained 14,189 specialists for aircraft warning units and shipped 399 officers, 53 warrant officers and 8,639 enlisted men in 75 units. Nearly 50 per cent of the personnel in these shipments were dispatched in the three months from July to October. Not only was production greater but the level of training was higher.

As a result of the increased number of men being sent to Drew Field, housing facilities became overcrowded. During July the 6th Training Battalion moved to Bradenton, Florida, and the 3rd Battalion sent approximately 2,000 troops to Camp Gordon Johnston, Florida. In August the entire 3rd Training Battalion moved to the training site at Hattiesburg, Mississippi. These temporary changes of station greatly relieved the congestion.

A study of the number of training sites erected during 1943 gives evidence of the growth of the AWUTC. On 1 January 1943 there were seven radar training sites in Florida, all equipped with SCR-588 sets. In the following months 11 SCR-271 and TRU sites were established in Florida and six additional SCR-588 sets located in the neighboring Gulf States. A special training site was erected at Tarpon Springs, Florida, for MEW training.

In anticipation of the large scale air-borne and amphibious operations which were scheduled in Europe and the Pacific, plans were initiated in September 1943 to introduce new realism into the training of units which would land with the first waves and were equipped with the lightweight SCR-602 sets. A subcenter for crews and units of this type was established by the 6th Training Regiment at Bradenton,



A unit equipped with air transportable radar prepares to move by air to the Florida Keys for final phase training.

Florida, where the Manatee River was available for practice landings and the unloading of equipment from landing craft. The nearby Sarasota Air Base was available for practice airborne operations. A sub-center for training of mobile and certain fixed radar sets was established at Hattiesburg, Mississippi. A variety of terrain was available there, especially the rolling country which could not be found in the Florida peninsula, a handicap to radar team training and site selection.

A fourth phase of training for specific units was added in December. It was designed to incorporate the experience gained in maneuvers with the Tactical Air Division Control Groups. These Divisions were engaged in mobile problems with Army Ground and Air Force Units and a plan was approved for the rotation of certain Signal AW units in these operations. These units were scheduled to participate after they had been sufficiently trained to perform their primary missions.

In November 1943 an SCR-527 team of the 563rd AW Battalion was selected to commence training on the new radar, MEW (Micro-wave Early Warning), which was installed at Tarpon Springs, where it had been in use by the Air Forces Tactical Center of Orlando, Florida. As the 563rd Battalion had a readiness date of 1 January 1944, no time could be lost in training. Personnel of the 730th Signal AW Co. were utilized as instructors to accomplish the change-over with the minimum of confusion. After some three weeks of intensive operations, the platoon rejoined its parent organization at Drew Field, sufficiently trained to work effectively with the new equipment.

October 1943 was the highpoint in shipment of trained personnel and units from the training center. More than 6,000 officers and men departed, chiefly for overseas. The largest single day's shipment in the entire history of AWUTC was on 13 October, when 150 officers and 4,050 enlisted men (the "Andrus" shipment) departed from Drew Field and subposts.

Facilities for training had improved materially by October. Plans were made to secure a transport plane so AW personnel working with the SCR-602 would have an opportunity to practice rapid loading and unloading of the equipment.

GCI missions also increased. Two new B-25's were received, bringing the total to 33 aircraft. A training program for inexperienced pilots was instituted by the Flight Section during the month. By the end of October there were 32 pilots assigned to the Section, compared with 17 on the first of the month.

In November 1943 eighty units were in various stages of training

at Drew Field and its sub-centers, or were on maneuvers in Louisiana, Tennessee, or elsewhere along the Gulf Coast.

The progress that had been made in preparing aircraft warning radar units for service in combat areas and the important part they had played were emphasized at a huge rally in the Drew Field bandshell on the evening of 28 December, 1943. More than 7,000 officers and men were there to enjoy entertainment by Hollywood stars and to hear the Commanding General read a tribute to radar men from General H. H. Arnold, Commanding General of the Army Air Forces. That part of the program was broadcast over a nation-wide network and beamed overseas.

In his message, General Arnold said: "Officers and enlisted men of the Aircraft Warning Service: I want to take the opportunity at this holiday season to congratulate you men of this Service. Yours is a little known branch of the Army Air Forces by virtue of the secrecy imposed on you in your training. Nevertheless, your part in our struggle is as vital as that played by our pilots, bombardiers, navigators and gunners.

"You operate in desolate, isolated corners of the earth, on rocky crags in the Arctic, on lonely coral atolls in the Pacific, in fever infested jungles of the tropics and on shell-torn shorelines of the Mediterranean. The very nature of your work causes you to be subjected to the most humble and primitive of living conditions. Remember, though, that by your being where you are, vigilant, loyal, cheerful and precise in your mission, you are building for our inevitable victory.

". . . without the protection of our convoy routes, our airdromes, our debarkation ports, our bivouac areas and our supply bases, it would be impossible to continue the battles against Germany and Japan. In modern warfare this protection is an absolute impossibility without an adequate Aircraft Warning Service. Remember, above all, that if you fail for one moment in your ceaseless vigilance, those who depend upon you for protection and warning will be blasted from their airdromes and bases without so much as a chance to even see the enemy. Keep up the good work!"

General Arnold followed this message with a personal visit some weeks later to observe training progress and discuss procedures with the Commanding General.

Efforts continued to introduce into unit training the conditions to be found in overseas theaters. Among these was an attempt to solve problems which were met in the South Pacific. Density of jungle growth had created a tendency to locate near, or at, the water's edge. To facilitate training on radar sets under such conditions, the command set up an experimental SCR-527 site at Rocky Point, near the east entrance to Davis Causeway. The assigned personnel had the primary mission of determining how the fluctuation of tide affected the accuracy of height finding on a beach-located SCR-527, employing the water as a reflecting surface. The secondary mission was to perform all training ordinarily accomplished in operational maneuvers. The site at Rocky Point was selected because it permitted location at the water's edge and afforded a five-mile radius of unobstructed surface varying with the rise and fall of tide, on a 170° azimuth. On this bearing a plane could fly over land during the calibration run.

Plans for realistic training, first conceived in September 1943, were completely implemented in the spring of 1944. The 720th Signal AW Co., and a section from Signal AW Detachment 42 staged a seven-day maneuver which paved the way for similar future operations. Leaving Drew Field by plane, the personnel and equipment of the two organizations were flown to Marathon Island, in the heart of the Florida Keys, where they took position for the defense of an air strip from simulated attack by enemy carrier-based planes. Reconnaissance of Marathon Island and the surrounding keys made possible the advance selection of sites for the information center, radio station and ten SCR-602 radar sets.

Two C-47 planes were found to be capable of transporting 25 officers and enlisted men, a complete SCR-602 radar set, a 188 radio set with mast sections, three ¼-ton vehicles, 120 gallons of gas and oil, and miscellaneous items.

A shuttle system was used to move all sections to Marathon, and for three days, four C-47's made two daily trips. After a one-day layover, during which all units were in operation, the same procedure was used to return the troops to their home base. By the use of such a system, it was possible to give each radar station four days of operation and the information center seven days.

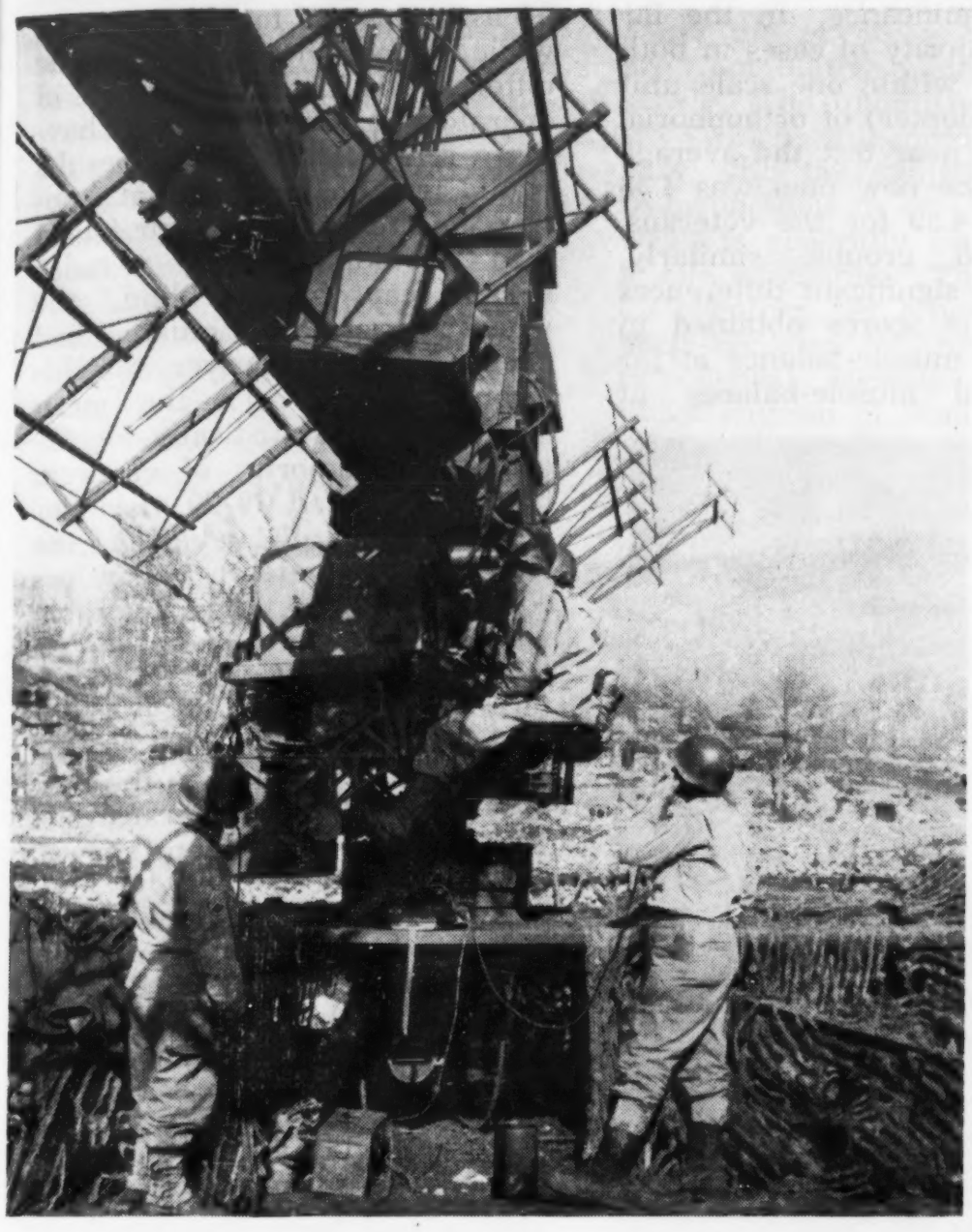
During June 1944 a total of 275 GCI interceptions were completed by aircraft warning units. An unusually high number, 107, were Phase II interceptions, in which the target plane follows an erratic course, using evasive tactics which necessitate very accurate tracking and plotting for successful interception.

In addition to the GCI flights, many other missions were flown at the request of the training regiments. These included calibration, RCM, broad IFF, gas, photo and attack missions and totaled 391 during June.

Just as the number of men and units in training had been steadily decreasing since the peak in 1943, so had the training facilities, training sites and sub-camps. By July 1944 the number of permanent fixed station sites had been reduced to nine. All troops except those in the field in operational training were housed at Drew Field by early spring 1944. In the fall of 1944 it was decided to inactivate the AWUTC at Drew Field and transfer personnel and necessary equipment to Pinedale, California, where the AAF had been conducting unit training for signal aviation units for many months. This transfer was accomplished during the early winter of 1944-1945.

The closing of the training center at Drew Field terminated an activity of enormous proportions—one that produced thousands of highly skilled radar units and crews during the almost three years of its existence. Those who served at Drew Field may well look back with satisfaction on their part in the total scheme of victory.

Ears for Ack-Ack. The men at this Italian installation are seemingly immune from radar-induced sterility and blindness.



Radar and the Man

by Norman A. Abbott

An Analysis of the Physical Effects of Exposure to High Frequency Radiation

"YOU couldn't make me operate a radar set, I don't want to go blind. Why I know a fellow who operated one for only six months and his eyes got so bad that . . ."

"I'm not going to mess around with any radar gear, why there are X-rays shooting out all over that stuff and first thing you know you're . . ."

Most people closely associated with radar have sooner or later been admonished with one or more of the preceding dogmatic statements. Just how much of the truth or near truth exists in these declarations? Many a man must have spent anxious hours debating these points. Actually it is unnecessary to guess or postulate on the matter. Many man-hours and thousands of dollars have been expended in obtaining factual data to resolve such allegations.

Vision

Tests were conducted comparing the visual capacities of 244 radar operators with those of 112 men who had not spent time working with oscilloscopes, and further, the visual capacities of long-term service operators were compared with those of operators with a short term of service. The visual histories, and ocular complaints of the subjects at the time the tests were conducted were analyzed.

The subjects used for these tests comprised personnel located at any Army Training Center and students at Purdue University. The ages of the personnel ranged from 18 to 37 years, averaging 25. The length of radar experience for the operator group ran from a week to as much as two years. The Bausch and Lomb Ortho-Rater was used for all visual tests.

Results obtained in tests on vertical muscle-balance at far indicated that the distribution of scores for both operators and non-operators is n o r m a l and there are no significant differences between the two groups. If anything, the operators tend toward more normal muscle-balance than to the non-operators. Within one scale unit (one-half diopter) on either side of the midpoint of the test chart are found 94% of the operators and 86% of the non-operators. Almost any adequate sampling of the general population would indicate a similar percentage of cases outside the mid-point position as indicated here in each group.

The results of the tests on vertical muscle-balance at near are equivalent to those found for the far distance test in that, for both groups, the majority of cases falls within the "margin of safety." Again there is a tendency for the operators to have better muscle-balance but the differences between the two groups are not statistically significant.

The differences between groups are statistically insignificant in the test for lateral muscle-balance. Results obtained in the tests for lateral muscle-balance at near again show insignificant differences.

When testing for binocular visual acuity, scores may be expressed in either the Snellen or in decimal notation. The decimal scores range from 0.1 to 1.5, a score of 1.0 corresponding to 20/20 Snellen and indicating the vision of the standard eye. Both groups had a majority of cases with 20/20 vision. The differences between the mean scores of 1.04 for operators and 1.07 for non-

Norman A. Abbott was graduated from the Rensselaer Polytechnic Institute with the E.E. degree in 1933. After teaching high school physics for one year he worked with the newly established receiver division of General Electric Co. in 1935. Became an examiner in the U. S. Patent Office in 1939 and transferred to the Signal Corps a year later. Has been associated with the research and development of Army radar equipment since 1940 as Chief Engineer on ground radar in the Engineering and Technical Service, Office of the Chief Signal Officer.

operators is not significant; both groups had good visual acuity.

When tested at the near point the two groups indicated excellent acuity; the average scores being 1.11 for operators and 1.15 for non-operators (Snellen 20/18 and 20/17 respectively). The differences are not significant.

Similarly no significant differences were found between groups on tests conducted to determine depth perception, color vision, and visual acuity of the right and left eyes taken separately.

In addition to the tests conducted between operators and non-operators, two groups of operators who had been working at an oscilloscope for different periods of time were checked. One group had been so engaged for two months or less, while the second group had operated at oscilloscopes for 18 months or more. There were from 50 to 60 men in each group.

In the tests of these groups for vertical muscle-balance at far, and vertical muscle-balance at near, the distributions are practically the same and certainly without significance. In the far test the majority of cases in both groups fell within one scale unit (one-half diopter) of orthophoria, and in the near test the average score for the new men was 4.38 as against 4.39 for the veterans.

The two groups, similarly, showed no significant differences between the scores obtained in the lateral muscle-balance at far and lateral muscle-balance at near tests. At far the means were 6.02 and 6.42 for veteran operators vs. short-term operators, and at near the averages were 6.28 and 6.83 respectively. The differences between the means are statistically insignificant.

Tests were conducted between the two groups of operators to determine binocular visual acuity. The most frequent score for short-term operators at far was 0.9 as against 1.1 for the veterans, while at near the only noticeable difference is in the percentage of operators in the two groups having a score of 1.2. These results would tend to indicate that, contrary to the opinion of our friend who "wouldn't operate a radar set for fear of going blind," the veteran operators actually had keener vision. However, the differences between the mean scores is not statistically significant. The majority of cases in both groups had 20/20 vision or better, and in all analyses of the results the veteran operators compare more than favorably with the short-term operators. In the far tests 74% of the long-term operators had 20/20 vision or better as against 60% of the short-term men, while in the near test 90% of the veterans and 79% of the new men showed 20/20 vision or better.

By means of questionnaires additional information concerning visual history and ocular complaints of each operator were obtained. Some of the more pertinent results follow:

Twenty-seven per cent of the total group had worn or were wearing glasses. Of these cases, glasses had been prescribed for constant wear for 45%, for close work only 48%, and for distance vision for 7%. Only 19% of these men had received their visual corrections after entering the Army. Of the group, at the time of questioning, 54% still wore their glasses and 46% no longer wore them. After entering the Army 16% of the men had stopped wearing glasses, which is almost as many as started wearing them after entering.

Twenty-six per cent of the men stated they were entirely free of subjective visual symptoms. No correlation was found between the time spent in operating an oscilloscope and the number of subjective visual symptoms reported. For example, in response to the inquiry: "Are you troubled with not being able to see clearly at any time?" 14 (out of 104) replied, yes, when reading, nine when at the oscilloscope, five after work, and one at various times. In response to the question, "Describe when you have headaches" 19 replies indicated when reading, 19 when at

Giant among radar. SCR-271's antenna looks the moon full in the eye. Except for the double antenna and other modifications, this lunar detector is virtually the same equipment which spotted the Japs at Pearl Harbor.

the oscilloscope, two after sleeping, and two after movies.

The one thing that did stand out as a result of these questionnaires was that too long a period of continuous work at the oscilloscope sometimes produced temporary ocular fatigue, strain, headache, and other symptoms. However, the same thing occurred when the subjects read "too long." The length of time of continuous work or reading generally specified as required to bring on the symptoms was two or three hours or more. Between the groups of short-term and long-term operators who answered the questionnaire there was no significant difference between the number of men claiming such symptoms. No correlation could be made between the number of subjective visual symptoms reported and the amount of time spent in operating an oscilloscope.

X-rays

Surveys have been conducted on the radiation intensities of X-rays in and about various radar equipments to determine these intensities, and to compare them with accepted safe tolerances in order that, where necessary, proper remedial action might be initiated.

Generally speaking, X-radiation occurs wherever rapidly moving electrons strike a solid. The hardness, or penetrating ability, of the X-rays produced depend primarily on the electron-accelerating voltage. In general, those rays produced in electronic tubes by voltages under 11,000 volts do not penetrate the glass envelopes of ordinary tubes. Even when using accelerating potentials as high as 25,000 volts the rays produced are still exceedingly soft and easily stopped. However, even soft X-rays, if in sufficiently large quantities, can produce biological injury. Since many radar sets use potentials in the 25 kilovolt region it might be expected that in some radar sets such rays may be found.

The dosage, or quantity of radiation to which one may be subjected, is based on the amount of energy absorbed from the X-rays in a given region. The roentgen, or R unit, is the unit used for measuring dosage. The intensity of radiation is expressed as the number of R units absorbed in a given length of time. With respect to X-ray injury to personnel, the total dosage is important, as well as the intensity, because the effects of X-radiation are cumulative and dissipate slowly. The quantity and intensity which will produce injury vary with the subject; however from one-half to one R unit per week is generally considered as a safe maximum. The value of 0.1 roentgen per 8-hour day has been accepted by the American radiological societies and National Bureau of Standards as a safe condition for continuous activity. That is, years of daily exposure to this amount of radiation will not produce any detectable injury, temporary or permanent, to personnel.

Exposure to high frequency radation will have no apparent effect on this operator of SCR-658 at a Greenland base weather station.

The X-ray intensity levels in and around both "long wave" and microwave radar sets were measured. The sets tested ranged from 5 to 500 KW, operated in the range 10 to 3,000 MC.

The tests resulted in the following information:

At plate voltages lower than about 30 kilovolts, no appreciable radiation penetrates the metal walls of tube elements. The radiation cone, therefore, is about the same as that of the light from the filaments. There are no significant stray X-radiations from magnetrons.

Outside the ordinary metal cabinets used to enclose radar equipment, even when immediately adjacent thereto, the intensity level was below 0.01 R and usually below 0.001 roentgen per 8-hour day. *These levels are from 10 to 100 times less than the accepted safe level.* It should be noted that the metal cabinets referred to are those of the usual solid construction. In one set (SC) which had a container comprising large vent-holes forming an open-work pattern of about 40% clear space in the cabinet wall the external radiation was in excess of the 0.1 roentgen per 8-hour day value. In addition, operation of equipment with cabinet doors open, or with large plain-glass viewing windows, may permit some X-radiation to reach the outside.

Within the cabinets of some radar equipments significant X-ray intensity levels do exist when the equipment is in operation. In general the inverse square law with respect to distance holds so that doubling the distance from the radiating source reduces dosage to one fourth. It should be noted here that dosage in excess of the normal safe limit may be tolerated by reducing the amount of exposure to a proportionately smaller period of time.

The radio-frequency power output rating of the equipment, and the voltage values in the electrical circuits, are not indicative of the presence or absence

of X-rays. The complete absence of significant X-ray intensity levels has been noted in units running at 25 kilovolts with radio frequency output of 350 kilowatts peak.

The sources of the stray X-radiation have been found to be glass walled tubes of the pulser, oscillator, clipper, and rectifier type, although the intensities from the latter two types are in general of very low intensity and well within safe limits.

As a result of the softness of the X-rays produced in radar equipment and the ease with which they are stopped, no biologically significant X-ray intensity is found outside of steel cabinets with 1/16-3/32 inch wall thickness or aluminum cases of 1/8-3/16 inch wall thickness. These X-rays correspond to much lower voltages and longer wavelengths than are used in medical radiography and therapy. The problem of protection exists primarily for those who must be inside or next to open, operating equipment for substantial and repeated periods of time.

Of the magnetrons studied, no X-radiation was found to escape from the metal envelope or the glass filament leads. When the glass tip of the radio-frequency lead fluoresced, very weak X-radiations appeared.

It was found that maximum X-ray emission occurred with hard tube pulsers or pulser amplifiers when the tubes are being pulsed. When operating above 12 kilovolts unsafe X-ray intensities are encountered in some cases. Least emission occurs when the tubes are held biased. The intensity of emission varies markedly from set to set even when using the same type tube; it appears to be dependent upon the phase relations between the tube voltage and current during the intervals (about 0.1 microsecond) required for formation and collapse of the square pulse. The radiations during pulsing show intensities as high as 50 times those emitted when the tubes are held biased.

Pulser tubes using a molybdenum anode emitted more X-radiation than tubes using other anode materials. The characteristic X-ray emission of molybdenum starts at about 20 kilovolts. The temperature at which the tube plate runs, as indicated by its color, is not indicative either of the presence of X-rays or of the relative intensity of any X-rays emitted. Some tubes running "cool" were found to be among the best X-ray generators (7.4 r per 8 hours at 50 cm.), while others running at 1400° K, a bright cherry red, emitted only 1.0 r per 8 hours at 50 cm.

The variation of intensity from set to set, as well as the variation within tubes themselves in a single unit, have precluded formulation of rules for "safe" intervals of exposure within any particular apparatus. The safest precaution is to use shields about the potential X-ray emitters; the next best is to make measurements on the particular unit involved and determine the safe exposure interval therefrom.

Oscillator tubes operating under about 12 kilowatts were found to be ineffective as X-ray producers. Similarly, good rectifier tubes seldom emit any X-rays, although when momentarily gassy some may be generated. Tests on clipper tubes showed only very weak X-ray output, well under the safe levels.

Sterility

Tests have been conducted to determine what effects were obtained from prolonged and intensive exposure to the radio frequency radiation from radar equipment.

In one series of these tests guinea pigs were exposed to radiation from a radar set operating at approximately 3200 mc/s. The set had a rated output of about 45 kw peak. The 30-inch paraboloidal reflector of the antenna assembly was placed two feet from a group of compartments housing male guinea pigs. Of these, four were shielded by sheet copper, eight were entirely exposed, and five were kept away from the radiation to serve as controls. The animals were "treated" to the radiation three hours daily for periods ranging from 42 days for the shielded specimens to 53 days for the exposed subjects.

The body temperatures were recorded daily for a period during the test for a number of both "treated" and control subjects, before and after exposure. No significant differences could be detected as being due to the radiation. This result is in conformity with an earlier theoretical report in which calculations based on average thermal energy considerations indicated that under the worst possible conditions, i.e., a person directly in front of the antenna and absorbing all of the incident energy, the power which could be dissipated in the subject would be of the same order of magnitude as is normally obtained in high-frequency therapy.

After the exposure period, eight of the guinea pigs were each mated with normal adult females. Seven of these matings resulted in litters of 2 to 3 animals each in the usual time, with no abnormalities in any of the young.

Upon completion of the experiment, examination was made of the subjects' heart, lung, liver, spleen, pancreas, adrenal, kidney, bladder, testis, epididymis, seminal vesicle, stomach, small intestine, trachea, esophagus, thyroid, parathyroid, brain, eye, skin, rib, and muscle. No changes were found in "treated" specimens from animals not subjected to the radiation. In further confirmation of the indications of the preceding paragraph it was found that spermatogenesis was active in the testis of all the animals.

Among a large number of radar men with whom the writer is personally acquainted, each of whom has had more than five years intimate contact with radar equipment, the number of children is not less than among those of his acquaintances with no radar experience. The only distinction appears to be that the radar men appear to have more sons than the non-radar group, but the numerical difference is not sufficiently large to be significant.

The tests reported upon in the preceding sections have been repeated to some extent by other organizations and laboratories with equivalent findings. Research leading to even safer operation conditions of equipment is continually being conducted in governmental and industrial laboratories, and the results of this research are bing applied to production equipments. The radar man may approach his work confident that the hazards involved are no different than those to be found in connection with other radio and electronic equipment using high voltages.

UMI

SURIBACHI'S SENTINELS

Radar in the foxholes

By Henry R. Chamberlin (Col., Sig, C. Res.)

. . . A.A.F. heavy GCI and search units went ashore with Marine assault troops at Iwo Jima

BY D PLUS 13 a lightweight radar set stood guard beside the flag atop Mt. Suribachi, on bloody Iwo Jima. Hand carried to the summit by a detail of 150 men, the installation at point "Hot Rocks" was but one unit in the heaviest concentration of radar equipment in a Pacific combat zone.

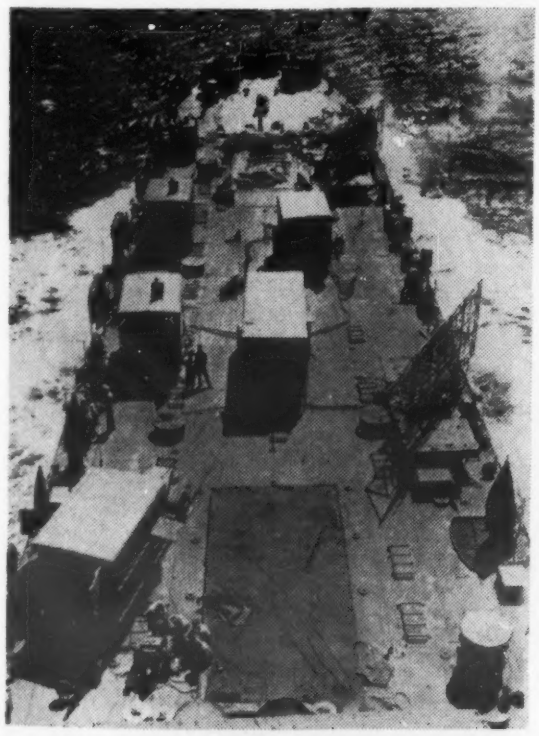
Mass bombardment of Japan's home islands was a mission assigned the Twentieth Air Force's B-29's based on Saipan. The long run to the core of the Nipponese empire was made over bleak and barren waters, without fighter escort. It became apparent, as the Pacific war gravitated toward its epicenter, that intermediate emergency fields would have to be provided for the heavies returning from their hazardous missions.

Iwo Jima, just 700 miles short of Japan's southern shores, and squarely in the middle of the broad highroad to Tokyo, was selected as the most likely island-base. Fighters and fighter-bombers based on Iwo could escort the Super-Fortresses and furnish cover for operations within the inner zone of Jap defenses. The location of the island made it difficult to neutralize surrounding enemy bases without heavy expenditure of troops and equipment. Therefore, it had to be anticipated that installations at Iwo would be subjected to heavy aerial assault by enemy planes. Radar protection thus became of paramount importance, both in detecting Jap raiders and in bringing-in crippled bombers and night-flying friendly fighters.

It was planned to bring heavy radar equipment across the beach on D-Day. The 568th Signal Aircraft Warning Battalion, which had received its training at Drew Field, Fla., was assigned the mission of landing with assault troops of the Fourth and Fifth Marine Divisions. Equipment was to be installed at pre-selected sites that would afford maximum protection against expected heavy air attacks.

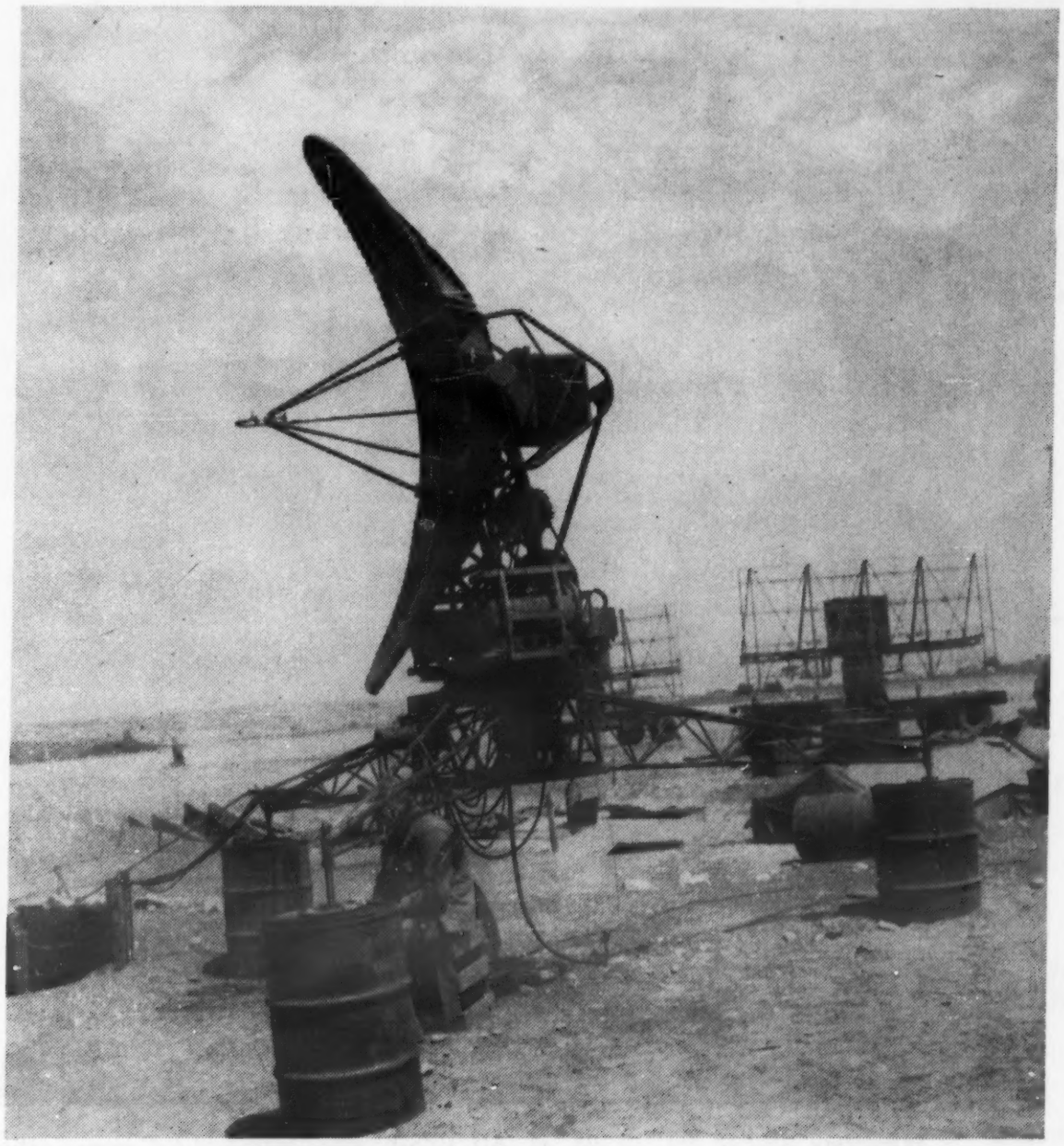
The 568th had been notified in September 1944, by the VII Fighter Command, that it would participate in the assault phase of the Iwo operation. Units specified included six lightweight radars, two SC-3 Navy-type medium range sets, one SCR-527 fighter director unit, one SCS-3 VHF radio and homing set, and one modified SCR-572 plotting trailer, designed to act as the ADCC.

Successful experiments had been conducted with the SCR-527 mounted on the main deck of an LST and the Navy had requested that two LST's be so equipped for use as fighter direction radar ships at Iwo Jima. It was later decided that all three SCR-527



SCR-527 operating on weather deck of an LST. Three such installations were made for Iwo invasion.

First AN/TPS-10 used in combat. At center of Motoyama Airfield No. 1, it was operated with SCR-527.



units of the assault phase be installed on the decks of three such ships, prepared to operate during the approach to the target. It was planned to release one unit for landing immediately after a suitable site became available on the island.

The Iwo operation was planned on the island of Oahu, where tentative radar sites were selected from contour maps, aerial photographs and the radar siting device at the Fleet Radar School, Camp Catlin. In preparation for the LST installations, a plan view of the ship was outlined on the ground and an SCR-527 and SCS-3 installed upon it to determine the amount of radar-radio mutual interference. Arrangements were made with the Navy to clear the side of the ships of all life rafts and other obstructions to radar antennas. Each SCR-527 was also provided with a gyro compass repeater for installation in the operations room.

Henry R. Chamberlin is a veteran of World War I and II and of the Connecticut National Guard. Was deputy executive officer at HQ, AWUTC at Drew Field prior to his selection as commander of a Signal AW Bn, which he trained and commanded in the Pacific. Now active in the formation of the post-war National Guard.

One of the radars was assigned to each of the Marine Divisions and four to the Fifth Amphibious Corps Headquarters. Of the latter, one set was to provide information on enemy air activity until the ADCC was ashore. The remaining three were to be sited to obtain complete radar coverage of the island.

Upon arrival at Iwo Jima on D-Day, the SCR-527 and SCS-3 unit personnel aboard LST 792 were advised that they were being released from picket ship operation and were to be made ready for landing. The two remaining LST's continued to function, alerted to assume fighter direction when ordered. The scarcity of enemy aerial activity during the landings precluded proper evaluation of the 527 in an amphibious role.

Equipment of Detachment 5 of the 726th Signal AW Co., attached to the 5th Marine Division, was landed at 2000 on D-Day. Personnel followed at 0800 on D plus 1, on Beach Red 2. Heavy enemy fire in the Division CP area made it inadvisable to attempt installations of the radar but the radio and siren were assembled and the Division informed of enemy air activity through liaison with other headquarters.

One of the most delicate tasks performed by the 568th Battalion

Temporary shelter for scopes of AN/CPS-1 atop Suribachi. Communications building and masts in background.

at Iwo was the landing, on D plus 3, of the heavy van and associated power equipment of the ADCC. This equipment was never designed for debarkation on a shell-torn beachhead under enemy fire. It was a minor miracle that the unit came through unscathed, after remaining on Beach Yellow One throughout the night.

Provisions had been made for the installation of the ADCC near the location of the Landing Force Commander's Headquarters. The proposed CP was reconnoitered and a suitable site found, approximately 100 yards away. Bulldozers made the necessary revetments for the installation.

The Assault ADCC proved very valuable during the combat operations. It was landed in good condition and operated very successfully. An air conditioning system protected the unit from dust and the only trouble experienced was relay and radio failure, due to shock resulting when friendly 155mm artillery was fired in the immediate vicinity.

The LST carrying the SCR-527 and AN/TPS-10 of reporting Company A and the SCS-3 of the 302nd Fighter Control Squadron was hit by several enemy mortar shells while unloading and was forced to move out to sea. The ship returned to the beach on D plus 5. The 527 transmitting antenna was damaged irreparably. The power van was hit but no serious damage incurred. No personnel injuries were sustained. In addition to this action, one radar was destroyed by an ammunition-dump fire on D plus 10. Another set was put out of operation that same day when the power unit was hit by mortar fire.

The ADCC was installed and officially established at 1400, D plus 6, with all radio channels operational and wire lines to VAC Hq. Agate 1 was the only radar reporting. At 1900, Agate 10 reported into the ADCC by radio and began sending radar information. A third unit was reported operational on D plus 7.

The following day the installation was completed on the VHF transmitter and receiver of the first SCS-3 unit, located at the ADCC and two channels of high power VHF were also made available. Construction was begun on an SCR-527 site at Motoyama Air Field No. 1 with bulldozers provided by Marine engineers working at the site. At 1800 the remaining two LST radar ships were released from operation and prepared to land.

It was not found necessary to use radar ground units on such a lavish scale in succeeding amphibious operations but the Iwo campaign did demonstrate the feasibility of close combat support by aircraft warning equipment. The bleak little island was such a valuable prize that unorthodox methods were justified in securing air bases within fighter range of the Japanese Archipelago.

CHANGES OF KEY PERSONNEL IN THE SIGNAL CORPS

UNDER ORDERS TO RETIRE:

Colonel Stanley L. James, effective 23 November 1946.
Colonel Wiley V. Carter, effective 30 November 1946.
Colonel William J. Daw, effective 30 September 1946 (disability).
Colonel Harry L. Bennett, effective 30 September 1946 (disability).
Colonel Alfred E. Larabee (retired officer on active duty) to revert to retired status on 13 December 1946.

RECENT ASSIGNMENTS TO THE OFFICE OF THE CHIEF SIGNAL OFFICER:

Colonel Houston V. Evans, Procurement and Distribution Service.
Colonel Alfred R. Marcy, Army Communications Service.
Colonel Alva G. Simson, Plans and Operations Division. (On temporary duty overseas to attend the Five Power Preliminary Telecommunications Conference convening at Moscow on 28 September).

RECENT ASSIGNMENTS TO INSTALLATIONS UNDER THE JURISDICTION OF THE CHIEF SIGNAL OFFICER:

Colonel Frank H. Curtis (under retirement orders) being recalled to active duty 1 November with station at Fort Monmouth, N. J.
Colonel Reginald P. Lyman, Hqs. Fort Monmouth, N. J.
Colonel Richard B. Moran, Signal Training Center, Ft. Dix, N. J.
Colonel Harold W. Dutcher, detailed in Signal Corps at Holabird Signal Depot.

REASSIGNED TO NEW STATIONS OVERSEAS:

Colonel Victor A. Conrad, Signal Officer, Army Forces, Western Pacific, Manila, P. I.
Colonel Emil Lenzner, Signal Officer, Third Army, European Theater.
Colonel Charles P. Amazeen, Manila, P. I.
Colonel Walter C. Ellis, Tokio, Japan.

In addition to the officers listed in the September-October 1946 issue of SIGNALS, the following officers were commissioned in the Regular Army Signal Corps. This completes the list of commissions in the Signal Corps made under the first integration program.

2nd Lt. (1st Lt.) Hugh H. Armstrong
1st Lt. (Lt. Col.) Roy H. Benton
1st Lt. (1st Lt.) William R. Blake
1st Lt. (1st Lt.) Bevelle T. Brown
Capt. (Col.) Kirk Buchak
Capt. (Lt. Col.) Edmund T. Bullock
Capt. (Lt. Col.) Orman G. Charles
1st Lt. (Maj.) William M. Copley, Jr.
1st Lt. (Lt. Col.) Duane D. Davis
Capt. (Lt. Col.) Homer L. Davis, Jr.
2nd Lt. (1st Lt.) Robert E. Davis
1st Lt. (Capt.) Anthony J. DeAngelis
1st Lt. (Capt.) Carl F. Dietrich
1st Lt. (Capt.) Richard W. Dowell
Capt. (Maj.) Deane A. Dunloy
1st Lt. (Lt. Col.) Paul A. Feyereisen
Capt. (Maj.) John D. Flewelling
1st Lt. (Lt. Col.) Erling J. Foss
1st Lt. (Lt. Col.) John A. Geddes
1st Lt. (Lt. Col.) John W. Grant
Maj. (Lt. Col.) Thomas M. Hahn
Capt. (Lt. Col.) William E. Heltzel
1st Lt. (Capt.) James W. Hevener
Capt. (Capt.) Elmer R. Higgins
Capt. (Col.) Stuart S Hoff
1st Lt. (1st Lt.) Paul A. Hughes
1st Lt. (Lt. Col.) Lawrence P. Jacobs
2nd Lt. (2nd Lt.) Gordon J. James
Capt. (Lt. Col.) Clinton W. Janes
Capt. (Lt. Col.) Luther E. Johnson
2nd Lt. (2nd Lt.) Loren R. Keefer
2nd Lt. (1st Lt.) Harold A. Kissinger
2nd Lt. (2nd Lt.) Milton L. Kult
Maj. (Lt. Col.) Wallace W. Lindsay
Maj. (Col.) Alfred R. Maroy
Capt. (Maj.) Alton O. McLane
Capt. (Lt. Col.) James R. McNitt
1st Lt. (Lt. Col.) Norbert C. Miller
Maj. (Lt. Col.) John V. Mills
Capt. (Col.) John C. Monahan
1st Lt. (Maj.) Edward E. Moran
Capt. (Col.) Aubrey R. Morley
1st Lt. (1st Lt.) Jack H. Murray, Jr.
1st Lt. (Lt. Col.) Howard E. Nestlerode, Jr.
Capt. (Maj.) James D. Nutt
Capt. (Capt.) Brookman R. Painter
1st Lt. (Maj.) Frederic H. Palmblad
Capt. (Capt.) William K. Perrin
1st Lt. (Lt. Col.) Chas. H. Phipps, Jr.
Capt. (Lt. Col.) Rolla D. Pollock
2nd Lt. (Capt.) James F. Powers
1st Lt. (Maj.) Emro J. Quashnock
Capt. (Maj.) George F. Rogers
Capt. (Maj.) Frank P. Rosso
1st Lt. (Maj.) Albert T. Schrader
Capt. (Lt. Col.) Thomas J. Seigler, Jr.
1st Lt. (Maj.) Vernon N. Simmons, Jr.
1st Lt. (Capt.) Wilmer B. Stevens
1st Lt. (Maj.) Thomas H. Swan
1st Lt. (Capt.) Richard I. Taylor
1st Lt. (1st Lt.) Ralph N. Tudor
1st Lt. (Lt. Col.) Leonard F. Walker

RADIO AMATEURS IN WAR AND PEACE

By Kenneth B. Warner

Managing Secretary, American Radio Relay League

Thirty years ago the art of radio communications was in its bawdy infancy. It was a period of erratic growth, typified by the spark gap and the thundrous crash of static in crude earphones. The new "wireless" was on a level with medieval alchemy in the popular imagination.

A Balkan assassination precipitated the first general conflict and the United States became involved in a war where distances were computed in thousands of miles. Overnight the Army Signal Corps was faced with one of the most demanding responsibilities in its history—that of enlisting the new science of radio into a system built around visual panels, pigeons, wire telegraph and telephone.

Recognizing the magnitude of the task, the Army turned to the government-licensed amateur radio operators for recruits. These 6,000 self-trained "hams" provided a lucrative field from which to draw the operators and technicians that would be needed to man the new equipment. In the enlistment campaign one circular promised a "radio operating assignment in a battle plane flying over the front lines"! More than 4,000 amateur operators responded to the calls of the military and the American Radio Relay League, the amateurs' national association.

These volunteer specialists filled the critical early need for trained radio men and the even more important demand for qualified instructors. In fact, most of the applicants for the "battle-plane" assignment were retained in the United States in radio schools—not without the 1917 version of the "gripe." Major General Ingles, then a lieutenant instructing officer candidates, now Chief Signal Officer, recently stated his belief that the skill and versatility displayed by amateurs in this early period was of material aid in establishing the superiority of Allied communications, an important factor, even with static battle lines.

It was, perhaps, this striking demonstration of the utility of a civilian group, self-trained in the intricacies of radio communication, that led the War Department, in the post-war period, to consider plans for the organization of an amateur radio reserve. A group of Signal Corps officers was sent to Hartford, Connecticut, to discuss the project with officials of the American Radio Relay League.

They found the League a rapidly growing membership-society of ardent radio fans, most of them possessed of Department of Commerce transmitting licenses, well versed in the comparatively new science of radio, and becoming more expert each day through a devouring interest in their chosen hobby. If nothing else, the officers learned that the term "amateur" must not be misconstrued as referring to a novice. In radio, at least, it denoted simply the nonprofessional, whose avocation was intended purely for the pleasure it returned.

"No use for me to try to sneak in. She uses radar!"

More than that, the Army officers found these League members were men of action. They were pioneers along the perimeter of the science, unbound by precedent or formality but possessed of restless, inquiring minds. Their installations paralleled the state of the art and rivalled many commercial and government stations. Ford spark coils were memories of the distant past. Rotary and synchronous gaps had long since been relegated to the shelf to make way for tube transmissions, the thing called "continuous-wave." Ironically enough, most early c.w. amateur transmitters were built around Army tubes obtained through devious channels.

Communications achievements of these "hams" were most interesting to the Signal Corps delegation. Two-way contact across the Atlantic, with modest power and under conditions of extreme atmospheric and artificial interference, was a common occurrence, the officers found. Pioneering on the short-waves, amateurs had opened new channels of communication, reliable for daytime long-distance contacts. They had explored and chartered the high-frequencies that were considered useless by commercial interests.

In 1923 a League member had accompanied Commander MacMillan to the Arctic on the schooner *Bowdoin,* in charge of an amateur radio installation, providing daily contact with "hams" in the United States and Canada. When the dirigible *Shenandoah* made a tour of the country in 1924, amateurs had maintained continuous contact between the big airship and ground stations. When, in 1925, the U. S. Fleet made a cruise to Australasia and the Navy wished to test short-wave apparatus, the League's communications manager was commissioned to take complete charge of an experi-

mental high-frequency set of his own construction on the flagship, U. S. S. *Seattle*.

Armed with these data, the Signal Corps instituted a cooperative program with League members, making use of selected amateur stations strategically located near every unit of the National Guard and Organized Reserves throughout the country. The objectives of the new Army-Amateur Radio System were the procurement of a reservoir of operators trained in the fundamentals of Army radio procedure, establishment of emergency communications facilities, and the maintenance of friendly contact with a segment of the civilian population that was potential Signal Corps personnel.

With one addition, these objectives might be restated today as the reasons for close cooperation between the League and the military. The additional point, so beautifully demonstrated during World War II, is that the amateur bands of frequencies, sandwiched in among other services at approximately octave intervals, can be vacated within hours and commandeered for military use in time of national emergency. By obtaining military allocations adjacent to amateur channels, the armed forces can easily expand into nearby "ham" territory.

A full story of the participation of the licensed amateurs and the League in World War II cannot be related here. However trite, statistics can convey much in small space and it may be said that over 20,000 of the nation's 60,000 licensed amateurs served in uniform, with perhaps an additional 20,000 engaged in industrial design and manufacture of communications equipment for our forces. Some additional thousands manned the War Emergency Radio Service, the communications section of OCD.

ARRL publications became the standard or supplementary texts in many military radio schools. Through its close contact with amateurs, the League's headquarters was able to provide the War Department and other governmental agencies with qualified candidates by the hundreds to fill openings for special personnel needs, from design of radar to OSS assignments overseas. In addition, total equipment in some thousands of amateur stations amounts to a tremendous quantity and the Signal Corps made use of this asset by purchasing transmitting gear from amateurs in numerous instances during the early period of the war when factories were not able to keep pace with urgent demands. Actually, had there been no amateur market, the production of war radio apparatus would have been further retarded since the "hams" had supported a peacetime manufacturing industry whose changeover to wartime output in many cases consisted principally of changing nameplates on equipment.

The American Radio Relay League, now 60,000 strong and still growing, looks forward to the expected announcement of an Army-Amateur Radio system expanded to include electronic branches for training in microwave techniques. Except for radar applications, the utility of super-high frequencies remains mostly a question mark and, above all, the main interest of the amateur is in delving beyond new horizons. The League expects the number of amateurs soon to reach 180,000 or more. The trend of interest to such scientific hobbies promises a continuing bright future for the progress of our nation, the League believes. The microphone and the telegraph key may well symbolize American predominance in technology. "CQ" becomes more than a train of dots and dashes; it is indicative of the "ham" spirit—always alert and ready to serve the nation in peace and in war.

FRUIT CAKE IN INDIA

By Fred Friendly

At the time this happened Frank Russell Baker was a Staff Sergeant in India. Now, Baker, who was an excellent radio announcer in civilian life, was equally adept at bending an elbow and like many of us, had difficulty in choosing between total abstinence and total murder as contained in the new infamous Indian Gin.

Baker asked only one thing for Christmas, a bottle of real scotch from home or if worse came to worst, some bourbon. He wrote of this ambition to his bride Dorothy in Sacramento. The big rub was that Army postal rules forbade the sending of alcoholic beverages through the mail.

So, it came to be that, in November, a long, narrow package came to Baker. We all had a hunch as to its contents and waited for him to open it. He refused—"I know what my honey has sent me and I'm not going to open it until Christmas Eve," he'd say . . .

Thanksgiving came and we really put the pressure on him to open it, but he refused. Finally came the Yule season. Old Baker invited four of us to spend the hour of hours with him. We gathered at seven and immediately tried to sell him on the idea of opening the package. He wouldn't budge. At ten we tried again. Meanwhile he'd been getting a glow on from a little Indian bamboo juice—"No sir—I ain't going to open this until midnight."

At eleven we attacked again. He held his line. Then came the stroke of mid-night and Baker rose for his big moment.

Slowly he loosened the heavy shipping cord, removed the corrugated paper only to find more heavy paper. Finally, he was down to the fancy red and green ribbons of the season. Quickly his nervous fingers ripped off the white tissue, and then suddenly his red face turned a ghastly, pale white. His eyes froze in the stare of a shocked, broken man. His mouth and then his fingers began to quiver. He was holding a fruit cake.

In a fit of rage, Baker lifted the fruit cake high above his head—shouted—"That dumb wife of mine sends me a fruit cake 1500 miles," and with Hamlet-like anger, he crashed the fruit cake down upon the cement floor. There was the dull, mincing sound that fruit cakes make when they hit immovable objects, but there was another sound; the tinkling of broken glass.

There on the floor, a golden, rich fluid oozed across the cracked floor and caused a little bay to form around the island of red label which said—"Johnny Walker." It was exactly 23:59.

Letters to the Editor

Imperial Hotel, Tokyo
24 September 1945

Sir:

"I am sure you have not forgotten that night before Christmas in 1942 when you and Lt. Raty and I did a broadcast called "An open letter to Adolph Hitler's Engineers." In the last few weeks that night has been in my thoughts very often. For I went into Mukden on the Wainwright rescue and stayed there until the 1500 Bataan and Corregidor victims took the train to Darien and then I went with them by Navy vessel to Okinawa and an interview with our old friend General Stilwell. The night I left Okinawa who should I run into but Major Ray Raty who was on D.S. from Leyte where he is Executive Officer of a Base Section. There were many of your old friends at Mukden who asked all about you including Col. Frank Nelson, Col. Al Stowell and Col. J. A. Stansell. There were others whose names I have lost. All asked a million questions about the Signal Corps. Every night before the movies I used to get up and lecture about the war and answer questions. It was a great break for me to be there.

"In China's capital, Kunming, I saw Col. James Ferrick; in confused Chungking I saw Col. McNamee. Here in Tokyo I saw a G.I. who told me that you and I told him at Kohler he might be the one to send the first message of victory out of Tokyo and he was very pleased to be able to say that he sent the first message in history from Tokyo bay direct to Washington.

"Am remaining in Tokyo for a few days, then will return to Delhi and thence to the U.S.A. where I hope to get to see you. I am, of course leaving the Army with my 108 points.

"My best to you, sir and God Bless you."

Always,
Fred Friendly

(Editor's note: This letter from one of our Vice Presidents, Fred Friendly, although dated more than a year ago is of interest today because of the recent death of General Stilwell.)

Sir:

"Received membership card and other data and was more than pleased to hear from my former Battalion Commander and former Commanding General.

"I doubt very much whether or not the things which we are doing here or are trying to do in this part of Japan is of any interest to the Signal Corps at large but as a matter of general information for yourself—The Signal Depot units arrived in Japan about the middle of September 1945 and they immediately established what we now call the Yokohama Base Signal Depot in a former shipyard area in Kawasaki, a town located between Tokyo and Yokohama.

"The original units consisted of 3127 Signal Service Company (port) 202d Signal Depot Company, 217th Signal Depot Company, 3194th Signal Depot Company and 3247th Signal Maintenance Company.

"The Signal Depot at present is commanded by Colonel P. A. Wakeman (Bn Adjutant 51st Signal Bn, and Signal Officer of the 5th Division prior to this division going overseas). Colonel R. V. D. Corput is the Signal Officer of the 8th Army and Colonel Harry E. Stones, I have been told, is with some Signal unit north of here, however I have not met him.

"In addition to performing our Signal Corps mission we are doing our own housekeeping which includes the construction of same as well as maintenance. We have no infantry troops in this area for guard duty and it takes a good deal of man-power for this duty. Every enlisted man with the exception of the kitchen personnel catches his turn of the guard duty which comes around once in 15 days. All Company Grade Officers and master sergeants pull OD. This duty comes around once in about 10 days.

"In my spare time I give a little help to the Catholic Missions in this part of Japan and there are a very large number of such organizations, French, Irish, German, and Spanish, as well as a good many houses all Japanese.

"In a short time a Catholic priest 'Father Hildebrand Yaiser, O.S.B." is going on a six months visit to the United States. This priest was allowed a good deal of freedom by the Japanese on account of his nationality (Swiss) during the war, and was able to visit American, British and other country prison of war camps in this area. His lectures on the conditions of Japan before the war, during the war and the present time should be of great value to the people of the United States.

Captain James J. Coyne
202d Signal Depot Co.
APO 503, San Francisco

SUBJECT: MISSION

Master Sergeant Anthony Tyson reports the progress and completion of the mission assigned by General Sherrill:

6 Sept. 1943—Left Drew Field.
14 Nov. 1943—Arrived Australia.
Dec. 1943—New Britain invasion.
Feb. 1944—Staged Oro Bay, New Guinea.
22 Apr. 1944—Hollandia invasion.
May-June—Biak and Kakde landings.
Sept.—Sansapor.
20 Oct. 1944—Leyte, P. I. "D" Day.
Jan. 1945—Submarine landing on Panay.
Mar. 1945—Luzon.

June 1945—Deactivation of the 583rd Signal A. W. Battalion of which the 712th Signal A. W. Company was, during the war—Company C.

July 1945—Secured transfer to the 597th Signal A. W. Bn, Lt. Col. T. W. (Hell-on-Wheels) Swartz, Commanding, as Sergeant Major, that organization being committed for the November operations against the Japanese home islands.

1 Sept. 1945—Landed Atsugi strip, near Tokyo, as one of advance party to set up headquarters.

1 Sept. 1945—6 Sept. 1946—Sergeant-Major of the Battalion through all its reorganizations culminating in the organization and activation of the 528th Aircraft Control & Warning Group to cover the home islands and Korea.

25 June 1946—Reenlisted—3 years.

1947?—Perhaps a spring fishing furlough in the far-away hills of home.

Summary

The 712th carried out its promise to General Sherrill:

It never fumbled the ball.

It earned a unit citation.

It earned 2 Bronze Star Medals, One Soldier's Medal, 2 Purple Hearts, and four letters of commendation.

It left seven of its people sleeping along the road to Tokyo.

The report reflects a creditable performance on the part of the Company, as the entire personnel, from Major Wallace down, knew what you expected of them, and would not let you down.

"I should like you to do one thing—eliminate my personal history—the General is aware that decorations, other than area ribbons and campaign stars, usually reflect recognition of the common effort, and the recipient wears it only as the representative of his comrades. The Purple Heart, is, of course, personal, but I should not like it thought that the others were considered by me to be personally earned honors.

"Mission accomplished. The sword is sheathed—the gun at rest—the fighting entity that we were sleeps only to rise should the General sound the call."

Anthony Tyson
Master Sergeant, U. S. A.
APO 181, San Francisco

Sirs:

"I am convinced that this Association will accomplish good things; primarily peace in this world. And one step toward maintaining peace is by the U. S. having the ultimate in military and civil communications systems.

"It seems that disarmament is out of the question; so it strikes me that the next best thing is preparedness.

"I believe this outfit (A. S. A.) has the "know how" to keep a keen ear and watchful eye on the war mongers.

"May I suggest that my "old" commanding officer, Col. R. G. Nichols, be a future nominee for office in the Army Signal Association.

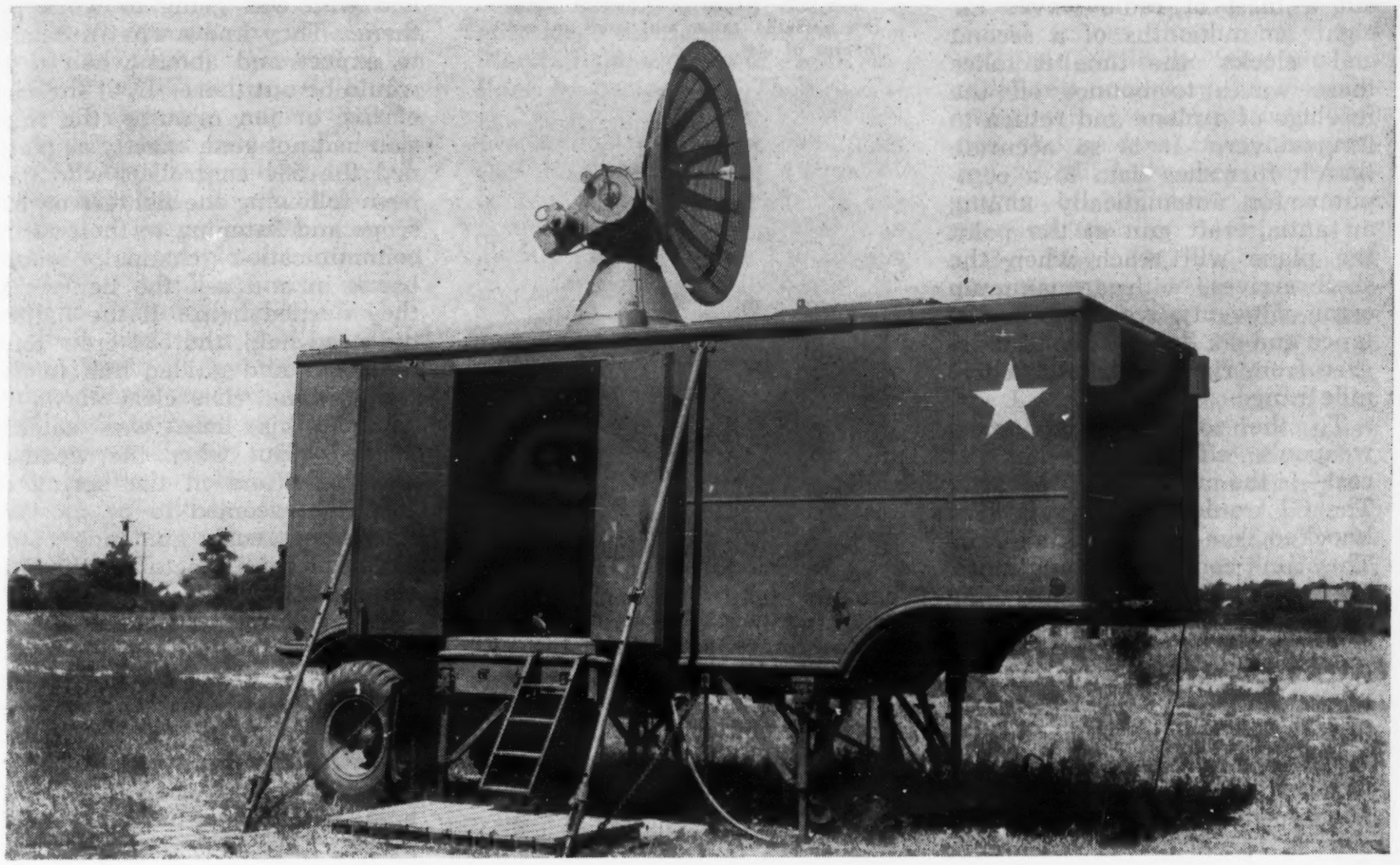
Kenneth H. Payne
Denver, Colorado

Sir:

"The U. S. Naval Institute takes great pleasure in welcoming SIGNALS to the fellowship of service publication, and we congratulate the Army Signal Association upon its splendid publication, the first number of which has just been received by us.

"In the Navy as well as in the Army the high military importance of communications is well recognized, and any organization devoted to publicizing this matter both to the services and to the general public is performing a much needed function.

Wells L. Field,
Captain, U. S. Navy,
Secretary-Treasurer,
United States Naval Institute



THE SCR-584—A HARD-HITTING RADAR SET

By Harold Berman

Signal Corps Engineering Laboratories

OFF Omaha Beach on D plus 6, troops on board an approaching LST viewed with suspicion an object floating in the English Channel. It was a closed van, and vans are not supposed to be sea-going. Six days after the landings in Normandy the going was still tough. Anything unusual generally meant trouble, and the skipper of the LST took no chances. He crept up alongside with just enough headway for a look-see. Closer up there was no doubt that it was a U. S. Army van with Signal Corps markings, and a signalman who happened to be on board the LST remarked on the excellence of the "moisture" sealing job someone had done back at the base in England. When they hauled it ashore and opened it, about $100,000 worth of equipment was found to be perfectly dry and ready to operate. It was one of the Army's most satisfactory radar sets—the SCR-584.

The SCR-584 will always be thought of with respect, and in the case of many of our British friends, with downright affection. For among its many other accomplishments it was the German buzz-bomb's most deadly enemy. When that German killer-weapon left its hidden base in Western France or somewhere on the coast of the Low Countries, its chances of reaching London eventually were less than one in ten, thanks to the SCR-584. As in the First Battle of Britain, in this Second Battle —that of the robot bombs—the inanimate assemblage of wire, glass, metal and wood called the SCR-584, ranks with the heroes of flesh and blood whose valiant stand against a ruthless enemy saved a nation.

The SCR-584, it can be gathered, is no ordinary radar set. Not that any radar set should be taken for granted, of course. The development of radar under the stress of war is a technical monument to man's ingenuity in defending himself against aggression. But this equipment seems to have had everything other radars had, and more.

In the first place, the fact that the SCR-584 is the best automatic gun-laying radar equipment that was employed by any belligerent in World War II is now rather well established. Using the same basic principles as other radar sets, its powerful radio-frequency generator shoots

out a blast of radio waves for eight ten-millionths of a second and "clocks" the time it takes these waves to bounce off the fuselage of a plane and return to its receiver. It is so accurate that it furnishes data to a computor for automatically aiming an antiaircraft gun at the point the plane will reach when the shell arrives, with a maximum error of twenty-five yards in distance and six hundredths of a degree from right or left, at a five mile range.

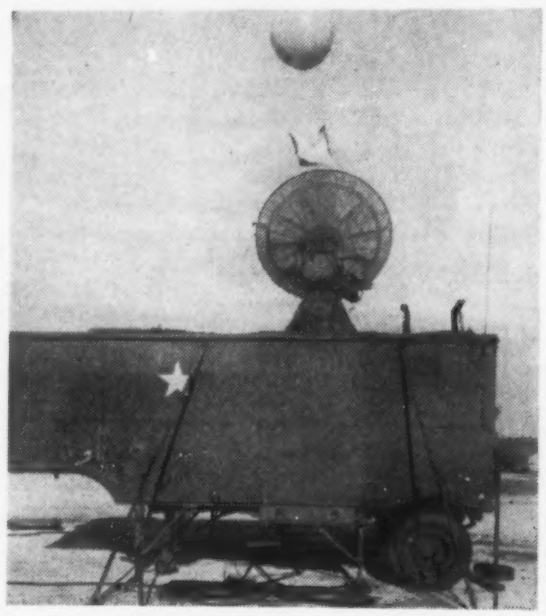
To the soldier in action, a weapon's effectiveness—not its cost—is the criterion of its worth. The GI would proudly say, "We knocked 'em down, didn't we? They ain't coming over any more, are they? Well . . .? Anything beyond that is velvet."

The "velvet" produced by the SCR-584 consists of the jobs it did in addition to gun-laying. In fact there are few if any radar functions the Army had that it didn't accomplish at one time or another. As time went on, of course, special radar sets were developed to do these specialized jobs, but they were often "in transit" or perhaps just in the engineer's "bread-board" model stage, while the ubiquitous 584 was on the spot. The 1,470 sets in operation on V-J Day were scattered throughout the world in every major battle area.

In addition to its function in the destroying of enemy planes, it located enemy mortars. It tracked high-flying meteorological balloons to obtain vital information about speed and direction of winds in the stratosphere. Finally, it was an ace in controlling our fighter-bombers so they could go aloft and pound the enemy in even the soupiest weather.

This "close control bombing," as the method came to be known, was perhaps the most spectacular "odd job" done by the gun-laying 584, and one which had a decisive mission during the closing days of the war in Europe. Electronic navigational aids of one type and another had been developed to direct and control the heavy bombers with their several-man crews, and the two-man night fighters, but nothing had been designed specifically for the very fast fighter-bombers with only the pilot as crew. This was required now because their striking power was needed more and

The 584 tracking a balloon target. This versatile radar was used in every theater of war.



more for offensive operations. Furthermore, since the Luftwaffe was rapidly becoming extinct, these light one-man planes were no longer much needed for their traditional role of protecting the heavy "Fortresses" or "Liberators."

The Ninth Tactical Air Command, particularly, developed the technique for controlling fighter planes as early as the engagements near St. Lo in Western France, and Maj. Gen. E. R. Quesada, the Ninth's Commander, had this to say about the operations: "Of the many radar devices that the Ninth Tactical Air Command is currently using, none attracts more respect and attention than the SCR-584. To us the versatility of this equipment has become the key support for a large part of our operations. That it has considerable influence on the conduct of our operations goes without saying, but I'd like to emphasize it anyway. It is in the close control of aircraft that we have found the SCR-584 most useful. It has permitted us to utilize our full forces on many occasions when operations would otherwise have been impossible—for example, when we have had a 1.000 foot ceiling with visibility of one mile at the base, and similar or worse conditions at the target area."

According to their account, the system worked out by the Ninth Tactical Air Command involved sending the field orders for a day's operations to the SCR-584 controllers at six each morning. Thus they knew what the job was for that day. They knew where and what the targets were and who was going to work on them. They knew what missions to expect and about when they would be out there. If, at the end of five or ten minutes, the mission had not gone exactly as planned the 584 controller, who had been following the fighters on his scope and listening to their radio communication channel, would break in and ask the fighters if they needed help. If the fighter did need help, the 584 crew took him over and guided him to the target area. On clear days, of course, this help was seldom needed. But when the weather was bad (and in the spring of 1944 that seemed to be most of the time), such guidance could be the deciding factor in the success or failure of a mission.

For example, a fighter-bomber group was lost above the overcast. The air support officer, traveling with an armored column below, had given them a target in coordinates near an obscure town. The fighter leader could not locate the town on his map. The 584 controller was listening on the communication channel and broke in to ask if he could help, and was answered "yes". The 584 directed them to the target and told them to circle. The fighter bombers followed instructions, but they could not see the target nor could they see the armored column. They asked for red smoke shells on the target. Friendly artillery responded, and planes were then able to distinguish enemy gun emplacements in a strong point. They bombed them out of existence."

The use of the SCR-584 as described by General Quesada was, incidentally, one of the earliest purely offensive uses of ground radar by the Allies in World War II. Up to this time ground radar had suffered from the "defense psychology" in which radar itself had been conceived during those crucial days of the air blitz against London.

But before further examining this set and the techniques developed for its spectacular use, let us take a quick look at some of the radars and techniques that led up to the 584.

As with man himself, most of the products of his labor have an ancestry. By and large, the things we have produced have grown sometimes rapidly, but often at slow pace, out of previous, simpler, more basic prod-

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ucts. Radar was no exception. While its immediate predecessor, the sound locator, operated on an entirely different principle, the idea of locating enemy planes and ships was there, and early Signal Corps experimental radars were installed on sound locator trailers. These predecessors of radar were completely outmoded by 1935. Airplanes were beginning to attain speeds only half or a third less than the speed of sound itself, so by the time defenses were ready and planes sent aloft to meet an attack, the enemy was already overhead.

In the days before radar, during a night attack, the sky was scanned with a hand operated search light. If the plane was caught and illuminated, it was followed by optical range finders and tracking telescopes, which supplied firing data to antiaircraft guns. The system was full of variables. After these had been accounted for, and always provided the plane was not travelling too fast and also that there were not too many planes, it was sometimes possible to score a hit. Today, when we look at a modern automobile and then think of the 1905 Chandler or some such relic, the amused smile could be no more smug than when we think of using listening horns for detecting the approach of enemy planes today.

As the war clouds began to gather on the European horizon in the middle Thirties, while some in Britain were wishfully hoping for "peace in our time", others, fortunately, were not deluded by the pious promises of the German Fuehrer. To them the rapidly mounting Luftwaffe cast a sinister and clearly discernible shadow across the channel and into the heart of London itself. By the employment of science, these men saw some hope to counterbalance, in some degree at least, the staggering weight of the Nazi war machine. Radar was their answer.

"What'll I do, Sarge? She insists on going inside!"

This foresight paid unimaginably large dividends. As early as March 1938, a chain of radar stations to protect the Thames Estuary was set up and in operation under RAF personnel. This was the initial stage of a comprehensive system to protect the entire Islands. Its completion was greatly accelerated by the advent of war a year and a half later.

Early British development in airborne radar also paid big dividends. When war broke out they had already installed in at least a few planes a system for detecting surface vessels (called ASV) and an equipment for detecting other aircraft for night fighting (AI). As we shall see, these played a most important part, along with the ground warning radars, in the defeat of the Luftwaffe.

This should by no means be interpreted to mean that the British had a monopoly on this new art of defense when the war started. Radar was born when it occurred to different persons independently and in different parts of the world that the pulse technique could be used to detect objects such as aircraft and ships. This idea seems to have occurred almost simultaneously in America, England, France, Germany and perhaps in Japan. Scientists in these countries worked secretly on problems of increased power output, shorter pulses, directional antenna systems, and many other practical aspects of the problem.

The Army's recent war-time radar research was an outgrowth of intermittent work since 1918 on various sorts of heat detectors for the location of aircraft. By 1930 responsibility for this development was transferred from the Ordnance Department to the Signal Corps Laboratories, which had just been placed under the direction of Colonel William R. Blair. While heading the Research and Engineering Division, Office of the Chief Signal Officer, from 1926 to 1930, Col. Blair had urged the use of infrared or radio waves to replace the Army's sound locator. In his new post Col. Blair immediately instituted projects for aircraft and ship locators. He continued the work on detectors of infrared rays produced by the heat of ship and plane engines and also undertook experiments on radio detection using "microwaves" a few centimeters in length. The latter produced echoes from nearby targets, and while the most modern radar sets, including the 584, now use them, it was not until 1940 that the modern cavity magnetron supplied the key to microwaves of sufficient power for practical use.

By May 1937, a successful demonstration of longer wave radar against test bombers was carried out by the Signal Corps Laboratories at Fort Monmouth, N. J., in the presence of the Secretary of War and members of Congress. In November 1938, a mobile test model of an experimental radar set developed by the Signal Corps was officially declared, somewhat modestly, in view of performance, "to have advantages over the best Sound Locator." Immediately the Coast Artillery saw the light and, in a desire to eliminate the time required to illuminate a plane by searchlight, called upon the Chief Signal Officer for "eventual production of a radio detection device which will provide accurate azimuth, accurate angular height, and accurate slant range for use as basic firing data for antiaircraft guns." The service test model was further improved and modified to allow its output data, which now included an automatic calculation of the height of the airplane, to be fed directly to antiaircraft gun directors. This was the SCR-268 which, while it is now obsolete, did yeoman service in the early dark days of the war.

The first international cooperation in radar research occurred when the efforts of the American and British laboratories were combined as a result of an agreement between the two governments in 1940 for an exchange of scientific military information. A British Technical Mission, headed by Sir Henry Tizard, arrived in Washington in Septem-

"Hurry up and finish your lunch—we gotta get these messages to Fort Knox!"

ber 1940 and mutual disclosures were made of British and American accomplishments in radar.

While it is impossible to say with certainty which country was leading in the radar research race at the beginning, by the time the curtain was rung down on World War II, the Allies were clearly leaders in the field. By 1941, the Nazis had become so arrogantly overconfident of their air force that they stopped all radar research and turned their scientific and industrial talents to projects they considered would pay off more quickly. In this judgment they erred, as history shows, and they did not again undertake extensive electronic research until late in the war, when they returned to it with a desperate but feeble effort.

Since radar was the British answer to an enemy far superior in fighter and bomber strength, they were the first to develop a system for its comprehensive use. Radar made it possible to alert the defense, to "see" the enemy when he was still hundreds of miles away, sometimes even as he left his own fields, as actually happened after the breakthrough in France. Without it, it would have been necessary to maintain constant patrols aloft of hundreds of planes, day and night, to insure against surprise attacks. The British did not have the planes and pilots for such patrols.

It was in early August 1940 that the Luftwaffe began to plaster London. They stepped up the bombing and one month later Germany's air effort reached its peak when they started mass-raiding the city. Years later the Nazis found what real bombardment could be. They had sown the wind and reaped the whirlwind, but even so in 1940, when they sent over 500 planes, the world up to that time had seen nothing like it. By September great battles in the sky were taking place and the RAF, aided by radar, was beginning to take its toll. The raiders were cut down one day to the extent of 185 planes out of 500, and from that moment they called "quits" on daylight raiding. They turned to darkness for protection, thereby putting the defense on radar more than ever, creating at the same time a need for new methods of aircraft control. One such system was the now famous "ground controlled interception" or GCI.

GCI meant that a man on the ground—"the Controller"—watching the Nazi planes come over on his "PPI" (Plan Position Indicator) scope, chose his target from among them and located that target by means of a plotting board, after which he could give detailed course instructions, called "vectors," to the fighting planes under his control. He would maneuver his planes to a position just below the enemy plane and on the same course. When the friendly fighter was 1 to 3 miles behind the target the pilot switched on his own AI radar in the plane. This radar was operated by a specialist who had no other duty. He was the radar operator and the pilot obeyed his instructions to the moment when he was close enough to see the German as a dim blur against the night sky. From that moment the fighter pilot was on his own. Most of the time the Nazi pilot never saw him until it was too late—as the record shows.

All this meant teamwork of a very high order; between GCI and pilot and between pilot and radar operator. But there were other methods invented to help in the successful defense system. One was a dependable communication system to permit the controller to fly the fighter by telephone. The British, with great resourcefulness, developed such a communications system called VHF, very high frequency, operating on an extremely short wavelength. A powerful weapon resulted when VHF was teamed with the other gadget they conceived, called IFF (identification, friend or foe). The latter device made it possible for the men on the ground watching the scopes on their radars to recognize the signals from a particular plane as friendly. A night fighter could identify himself to his controller by turning on his IFF and the guns on the ground held their fire, or, if necessary, he could ask for instructions and they were given.

Effective employment of these electronic innovations, coupled with the skill and daring of the RAF pilots, made the air over England definitely unhealthy for enemy planes, and this had its inevitable effect on the morale of Luftwaffe pilots.

But the Nazis still had a few tricks up their technological sleeve, one of which they figured was ready made for the problem of pilot morale. It was the buzz-bomb, the "Vergeltungswaffe eins," the pilotless airplane carrying a ton of TNT because, as one antiaircraft veteran allowed, "You can't demoralize a gyroscope." After the inevitable time it took us to become accustomed to the new deviltry, it was found that the SCR-584, using the revolutionary "proximity" fuse, definitely had their number. Any morale factor the enemy gained with his pilotless plane was more than compensated for by the fuse, until recently the Armed Forces' most hush-hush project outside the atomic bomb. It is essentially a minute radio device, complete with transmitter, receiver and power supply, all not much bigger than a man's two fists. When it nears a target the electrical current and voltage on its antenna is changed ever so slightly, and it explodes the shell at the exact number of yards from the target where it will do the greatest possible damage.

It is quite true that the newest and fastest fighters could catch the V-1 (they could be seen on radar scopes like any fast enemy plane and fighters were "vectored" to them), and it was also true the balloon barrages helped. But when the fighter planes and their personnel, working 12 hours a day for two months, had worn themselves out, and when the balloons caught only those which were low enough and on the right course to get caught, or when weather was too bad for fighters to be airborne, there was no other defense but radar—controlled antiaircraft fire.

Though the Nazis knew soupy weather was on their side, they could take little comfort in that. On one cloudy afternoon late in August 1944, of 105 V-1's that crossed the English coast headed for London, only three got there. About that time, one United States AA Battery on England's south coast hung up a record—one V-1 for every 40 rounds shot. If we remember that AA guns shoot rapid fire and their ammunition is considered about as expendable as machine gun bullets, we see that is a real record.

The problem of radar protection for America offered some special problems to the electronic engineers. Our thousands of miles of coastline, while not as subject to surprise attack as that of the British Isles, still had to be protected. While the First Battle of Britain was being fought and we were yet at peace, Signal Corps equipment and personnel were being placed at strategic points along our lengthy coastline and at important overseas bases, for aircraft warning service. Our long coast and large territory dictated equipment capable of long range for earlier warning. We wanted, especially, sets that could easily cover 100 miles or more. A radar with an effective range of 100 miles can cover twice the coastline, or four times the area in square miles, than can be handled by a radar set of only fifty miles range. We had such sets in the SCR-270 and 271, our first early warning radar. It was these sets that saw the approach of the Japanese air force at Pearl Harbor on December 7, 1941, but whose warning went so tragically unheeded. It was also an SCR-271 which, with certain specialized modifications, made scientific history on January 10, 1946 by establishing the first contact with the moon. From a shack on the grounds at the Signal Corps Engineering Laboratories, Belmar, N. J. it aimed a powerful radio beam at the satellite and two and a half seconds later recorded on its oscilloscope the echo which had bounced back.

But in war, no matter how good a weapon may appear, countermeasures by the enemy demand continuing improvement in equipment and techniques. As expected of a canny enemy, the Germans constantly tried to develop ways of circumventing the effectiveness of our radar. For example, in 1943 they began to come in under the radar beam, which was possible with the long-wave sets we were then using. Coming in under the beam, they were on top of us almost before we detected them. It was here that microwave radar began to come into its own, for one of its many advantages is the ability it has to give protection against low-flying planes. Microwave sets began to supplement the long-wave early warning sets. It is not hard to see what an effective team these two types can make, especially when the microwave radar is also an automatic gunlayer such as the 584. The early warning set could alert the defenses fully fifteen minutes to a half-hour before even the fastest fighters could arrive. This was plenty of time to insure a complete state of readiness on the part of the AA crew so maximum effectiveness of the gunfire could be achieved.

But there were more compelling reasons for adopting microwaves than that the beam could be depressed. It must be remembered that a plane is very small and it moves very fast. The greatest possible accuracy is needed for effective antiaircraft fire. Everyone who knew anything about the problem realized that great resolution and precision made possible by shorter wavelengths would be the answer if certain difficulties of design could be overcome. The military characteristics for AA equipment employing microwaves were presented to the Radiation Laboratory at MIT in 1941. After service testing and coordination by the Signal Corps Engineering Laboratories, Bradley Beach, N. J., the first production result of this painstaking research, the SCR-584, was delivered in 1943. Its first active service was during the Italian campaign at Anzio beachhead in February 1944.

The SCR-584 utilizes radio waves only 10 centimeters (about 4 inches) in length, which make it possible to distinguish one or two planes in a flight of six or more, to locate a bridge as distinct from the terrain surrounding it, to focus electrically very much as a fine lens in a good camera gives a clearer object with greater detail.

In common with all radars, SCR-584 consists of a radio wave transmitter, an antenna, a radio receiver and an indicator. Power, either from power lines, or a generator, enters the transmitter, which converts it into very short radio waves (microwaves) of very high frequency. These are transmitted to the antenna, which "shoots" them at the plane or ship being located.

The antenna is a dish-shaped paraboloid, designed as a reflector to concentrate the pulsed energy into a strongly defined beam in order to spot the maximum amount of radio waves on a small and distant object. The "dish" of the antenna accomplishes this searchlight effect by focussing and beaming outward a concentrated single stream of radio energy. The antenna serves the double purpose of sending out the "searching" radio beam and picking up the "echo" of the beam after it has struck the target and been reflected back. In searching for, or tracking a target, the antenna can rotate around a complete circle and move up or down. Thus it is in complete command of the sky in all unobstructed directions for a distance of forty miles, the maximum effective range of SCR-584.

The receiver to which the incoming echo is delivered is similar to an ordinary radio receiver, except that in its specialized use in radar it is naturally more complicated and sensitive. It must be capable of picking up a relatively weak signal in a millionth of a second. This incredibly fine timing is made necessary by the fact that the receiver and transmitter cannot be in operation at the same time. When the pulse is sent out the receiver must be switched off, for it would be

burned out if it received the direct high-powered beam of its own transmitter. Immediately after the radio beam leaves the antenna the receiver is switched on to catch the beam on the rebound from the target. Since radio waves travel with the speed of light, and pulses are sent out at very short intervals the receiver must be capable of doing its work in truly a split second. The marvelous switching device that accomplishes this unbelievably fast trigger action is a specially designed electron tube.

The indicator is the "brains" of the radar set. It consists of an oscilloscope or electron tube which converts the incoming radio beam into a pattern of light on a dial, from which a trained observer can determine the distance, direction, and height of the plane under observation. The SCR-584 has a PPI (plan position indicator) indicating system which shows the area surrounding the radar set as a circular map with all the reflecting objects appearing as bright spots of light in their correct relative positions.

The SCR-584 continuously and automatically tracks individual aircraft from as great a distance as eighteen nautical miles, and it can detect the presence of an airplane as far as forty miles. Actually, if required under special conditions, it can follow planes accurately out to fifty miles.

When the set is looking at a stationary target such as a bridge or building the range indication may be reset to an accuracy of two yards which represents a timing accuracy of about one one-hundredth of a millionth of a second. One reason for this great accuracy is the very short pulse time used (.8 of a millionth of a second) and an expanded oscilloscope sweep which permits the echo pulses to be measured very accurately.

When searching for a distant target before it comes in reach of the antiaircraft guns, the dish-shaped antenna is swung in a circle at a speed of about 6 revolutions per minute. At the same time it is tilted upward about 4 degrees for every turn. By this method the beam searches every point in space from minus 10 degrees below the horizon to the zenith. When the target is seen and as soon as the guns can reach it, the radar set stops searching and automatically begins to track the target. At the same time it delivers the range and the angular measurements to the computer, which is part of the gunfire apparatus.

There is, of course, considerably more to the SCR-584 than this brief description would allow. Some of the lessons learned in other radars were applied to the design of the 584, but in general it is probably the most original and highly engineered radar set turned out by the Signal Corps in conjunction with American laboratories in World War II.

Two enterprising Army newspapers—*The Signal Corps Message,* and *The Signaleer*—have been merged and the combined product is now being issued at Fort Monmouth.

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● Many members of The Army Signal Association are old friends of ours. They have met Automatic Electric communications equipment on many fields of action, and their friendship has been earned often under conditions of extreme hazard.

● We are proud of the friends which Automatic Electric equipment has thus acquired, and pleased to be able to meet them again through these pages.

● As the holiday season approaches, we send our best wishes to the officers and members of the Army Signal Association.

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COMMUNICATION AND SIGNALING EQUIPMENT

Sequel To Surrender On The Air

By 1st Lt. Jacques Kunitz, Signal Corps

The 71st Signal Service Battalion was activated by Eighth Army on the first of April, 1946, from the following units:

Detachment 2, 4025th Signal Service Group
978th Signal Service Company
232d Signal Operations Company
253d Signal (Heavy) Construction Company
1st Operational Company, 4026th Signal Photographic Battalion

In accordance with instructions issued by GHQ AFPAC, preparations are now being made to effect transfer of the unit to direct control of General Headquarters, with status of a separate subordinate command.

The 71st Signal Service Battalion with Headquarters in the eight story San Shin Building in Tokyo provides all communication facilities for GHQ. It is now one of the largest employers of War Department civilians in the Tokyo area. A little history of the organization will give the reader a better insight of the workings of this unique signal battalion and the mission that it accomplishes.

The 71st is a new designation for a group of various signal units that have played an important part in the history of GHQ during the epochal advance of our forces up the line from Australia. Of course it is impossible to mention every outfit and their individual accomplishments in a document of this nature but a few of the names stand out impressively.

The AFPAC Mobile Communications Unit is one of these. This unit was established in the summer of 1945 as an echelon of the GHQ Signal Operations Group AFWESPAC. Its mission was to plan, install and operate communications for the advance echelon of General Headquarters, AFPAC, during projected "Olympic" operations in the offensive against Japan. The 232d Signal Operations Company, with headquarters in Manila, became the nucleus of the unit. Additional personnel and teams were furnished by the 4025th Signal Service Group, and by the Seaborne Communications Detachment.

The organizational set-up comprised the following divisions: headquarters, radio, signal center, wire, transportation, and attached medical personnel. These divisions, in turn, were subdivided into more specific sections—utilities, plant, telephone, VHF and carrier, transmitters and receivers, message center, operations, radio intercept, teletype and cryptographic maintenance, etc. In addition, a communications division to handle ship-to-shore communication entered the picture. This water-borne division was made intensely necessary by the fact that almost all previous offensive moves against Japanese forces in the Pacific had involved a landing from the sea on the enemy-held shore. In the early stages of such attacks it had been impossible to install and operate on shore either high-powered receivers and transmitters or cryptographic equipment (the latter because of the danger that it might fall into enemy hands). Communications ships played a vital part in taking care of their functions until the land-based installations were ready to operate. The same situation was anticipated in the attack against the Japanese home islands.

This was, in brief, the situation in which the unit found itself on the morning of 9 August 1945. Beginning with that date, the situation changed dramatically from day to day, sometimes almost from hour to hour. The tides of history took a hand in the unit's career, and caused many of its well-laid plans to be discarded abruptly. It was on the morning of 9 August, while Hiroshima was still shuddering from the impact of the first atomic bomb, that Soviet Russia went to war with Japan.

Just one day later, on 10 August, the Tokyo government announced that Japan was ready to surrender.

This news, which amazed and gladdened the Allied world, came as no less of a shock to Mobile Communications. It was at once obvious that the unit would now have to move out far sooner than even the most optimistic schedule had provided. General MacArthur had ordered the occupation to begin as soon as possible, and the advance echelon of GHQ was to open in Japan within three weeks.

Especially history-making was the arrival at Atsugi Airfield, on 28 August 1945, of a hand-picked group of communications specialists, in which the Mobile Unit was represented. This group of 150 men, landing at an erstwhile enemy airfield, guarded by Jap soldiers, really appreciated the import of General MacArthur's "Gamble."

The maze of events leading up to V-J day are past history, but 2 September found the unit in Japan with a message center set up in the Customs House, Yokohama, and a complete communications ship "Teton" in Tokyo Bay.

On Sunday morning, 2 September 1945, V-J Day around the world, the tourist dock was a scene of intense activity. General MacArthur, other American and Allied representatives, and the Japanese delegates used it when going by destroyer to the battleship "Missouri." The dock was crowded with members of the armed forces, photographers, and the Allied and Japanese correspondents. But it was no holiday for the Mobile Communications men on board the "Teton" and in the Customs House. If anything, their problems were more complicated by the nature of the moment. Its mission was to establish and maintain communications from the "Missouri" to the United States and Manila.

The last lap of the Mobile Communications Unit's multi-pathed odyssey was now in sight. With the official close of the Philippine campaign, General MacArthur had taken "On to Tokyo!" as his slogan. Now, sooner than all but a very few had anticipated a month earlier, Tokyo was the immediate and final objective. The

Commander-in-Chief entered the Japanese Capital at noon on 8 September. A few hours later, Mobile also began moving into Tokyo, on the same day as the celebrated First Cavalry Division.

The Dai Ichi Building, an impressive structure facing the Imperial Palace, had been chosen for GHQ, and part of the third floor was assigned to the signal center and operations room. The transmitter station and receiver stations were set up on man-made islands in Tokyo Bay. Communications had been uninterrupted during all the extensive changes.

In the past few months, the need for a unit such as the AFPAC Mobile Communications Unit has ben lessened so that a more permanent signal group was established. It encompassed all the mobile signal units serving G H Q — operation, installation, maintenance, heavy construction, photographic, and other similar organizations. Finally, on 1 April, 1946, the 71st Signal Service Battalion was activated as a major subordinate command of GHQ.

An increasingly vital role is being played in the operation of the organization by the War Department civilian employees, who are now on duty in almost every GHQ signal installation. While the integration these men and women into the smooth-running machinery of communications has created new problems, it is evident that large scale signal communications in this area will depend more and more upon their efforts in the immediate time to come.

Under command of Major General Muir S. Fairchild, the Air Force's University of the Air recently opened at Maxwell Field, Alabama. The new special staff school is designed to train Air Force personnel in the broad aspects of air power, to study air defense and coordinate it with surface operations.

Obsolete B-17 "Flying Fortresses" will be used for radio-controlled drone experiments and as antiaircraft targets at Texas fields.

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SIGNALS IN AGF

New AGF Headquarters

Headquarters, Army Ground Forces, is now operating in its new location at historic Fort Monroe, Virginia. Fort Monroe was formerly the home of the Coast Artillery School, which has since moved to Fort Winfield Scott, California.

Fort Algernourne Day

The Commanding General, Army Ground Forces, designated 30 October 1946 as Fort Algernourne Day, commemorating the 337th anniversary of the construction, in 1609, of the installation of that name at Old Point Comfort. Some 450 prominent officials, representing the Armed Services, political and business groups attended a review and reception at Fort Monroe on the occasion.

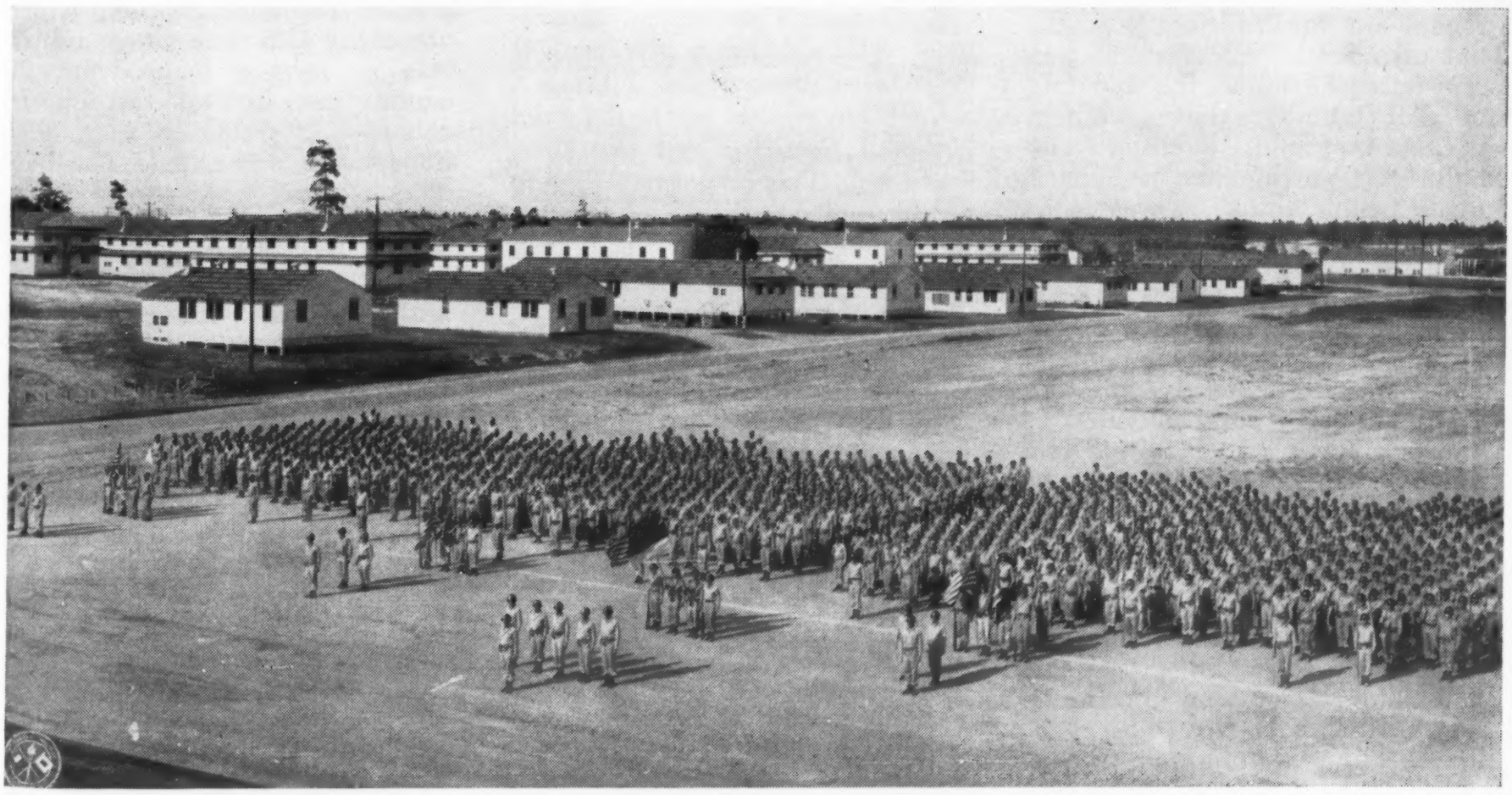
1st Signal Service Group

The First Signal Service Group is stationed in the Fourth Army area at Camp Polk, Louisiana, and is commanded by Lt. Col. David P. Gibbs. Signal units under command of the Group are: 51st Signal Operation Battalion, 29th Signal Light Construction Battalion, 20th Signal Air-Ground Liaison Company, 181st Signal Depot Company, 167th Signal Photo Company and 205th Signal Repair Company.

In addition to actively supervising the training of these Signal units, the Group operates specialist schools for Radio Repairmen, Radio Operators, Teletypewriter Operators, Installer Repairmen, Message Center Clerks, and is presently instituting a course for Cable Splicers in the 29th Signal Light Construction Battalion. About 420 students are now attending these Group schools and on-the-job training is being given in the 167th Photo Company to Photographers, Motion Picture Cameramen and Photographic Laboratory Technicians.

Beside the Signal training activities, this organization has a fine athletic and recreation program, in which a great deal of interest is shown by both officers and enlisted personnel. The Group baseball team recently won the Fourth Army baseball championship, indicative of results obtained. A bronze statue of a baseball player, symbolic of the Army championship, now stands in the Group Headquarters building at Camp Polk.

Although many activities of the First Signal Service Group are being obstructed by somewhat trying conditions, Army Ground Forces is proud of the record made thus far by the organization and feels certain that it will continue to accomplish its missions.



Signal Corps units of First Signal Service Group in review formation at Camp Polk, La., where they are receiving unit training.

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One Side of the Fence.

THE ROOSEVELT I KNEW,

by Frances Perkins. 408 pages; illustrated. The Viking Press. $3.75

Although Frances Perkins states in the Preamble that: "This book about Roosevelt is biased in his favor. I am bound to him by ties of affection, common purpose, and joint undertakings," she accomplishes a great deal toward clarifying many points of his complex personality objectively. Her admiration has not blinded her to his faults and her work could never be classed with those who have formed a veritable Roosevelt cult. Miss Perkins admits that it will be in another lifetime that a purely objective biography can be written; however, this book will hardly be improved upon for some time to come and will undoubtedly furnish valuable material for future biographers.

The first time Miss Perkins met young Franklin Roosevelt was just after he had been elected to the state Senate. She wasn't particularly impressed with him and he was generally considered arrogant and far from being potential presidential material. It was only after he found the meaning of real humility that greatness became apparent in him. The habit of throwing his head back made people think he was looking down his nose at them. Later this gesture, combined with the famous smile, became a symbol of hope and courage to a bewildered world. Roosevelt's political and moral growth is followed from his early political ventures through his terrible illness and affliction on to the days of the governorship of New York and finally up to his tremendous work as President.

The book does much more for the reader than just tell a few historically interesting or personally amusing episodes in Roosevelt's life: It furnishes good background reading for the development of today's labor policies and upheavals. All of the important legislation concerning labor during Roosevelt's administrations is discussed in a lucid and human way and sketches a fine picture of the inner workings of the higher politicos in Washington. As Industrial Commissioner of New York during Roosevelt's governorship and later as his Secretary of Labor, it is doubtful if there is anyone better fitted to know, from the first germination on through completion of the late President's conclusions and decisions on social reform. Miss Perkins shares her insight on how his mind worked in activating such measures as NRA, WPA, NLRA, Social Security and the others in the long list of labor innovations introduced during his terms of office.

B.C.

High-Level Organization.

NATIONAL SECURITY AND THE GENERAL STAFF,

by Major General Otto L. Nelson, Jr. 601 pages; index; illustrated. Infantry Journal Press. $5.00

Organization and the administrative process is part and parcel of the soldier's profession. Hence, most soldiers fancy themselves experts in these fields. I know I always have—that is, until I read *National Security and the General Staff*. This book jarred me to a full realization of my relative ignorance, and I approach this review with humility.

Major General Nelson is acknowledged as an expert in organization and public administration; in his own words, his book is "a combination of ideas and information obtained through academic research tempered and modified by on-the-job experience and observation." The original research was accomplished in 1939-40, when General Nelson was a Fellow at the Graduate School of Public Administration at Harvard University. His "on-the-job experience" was from a most enviable observation post during two years of wartime change (1942-44) in the office of the Deputy Chief of Staff in Washington. It is not too extravagant to state that there is no other officer in our Army equally qualified to attempt so monumental a task.

In my opinion, much of this material might well have been lifted into accompanying appendices, to permit more rapid progress to the heart of General Nelson's message, if such it can be called in the final chapter "What of the Future?"

National Security will be the winner if many—and particularly policy makers high in public life—read this splendid study.

D.A.

A Historical Monograph

THE ADMIRALTIES,

An historical monograph on the conquest of the Admiralty Islands between February 29 and May 18, 1944, has been released for public sale by the Government Printing Office.

The Admiralties deals with important Pacific operations which, occurring at a time when interest was so largely focused on the coming invasion of Europe, received less publicity than their importance warranted. The book demonstrates how the conquest of the Admiralty Islands, in which the First Cavalry Division played a major role, effectively sealed off the enemy-held Bismarck-Solomons area from supply and reinforcement, isolating garrisons totaling over 100,000 troops and bottling up a major segment of the outer defenses of Japan's Pacific Empire, defenses which previously had barred Allied advance from the Southwest Pacific toward the Philippines.

Every phase of the conquest of the Admiralties is covered, from the assault on Los Negros and the battle to hold that beachhead, the control of Seeadler Harbor, the attack on Manus Island, the landing at Lugos Mission, the capture

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of Lorengau airdrome, to the capture of the outlying islands—Pitylu, Koruniat, Ndrilo and Rambutyo.

With an initial force of 1,000 men to the enemy's 4,300, the landing force not only overwhelmed the enemy but exacted a vastly disproportionate number of casualties from the defenders. Against American losses of 326 killed, 1,189 wounded and four missing, Japanese casualties were estimated at 3,280 killed and 75 missing, an approximately 10-to-1 ratio.

This factual but no less thrilling account of the courage and resourcefulness of the leaders and the men of one of our most famous units illustrates again the importance of esprit de corps in a military unit. The 1st Cavalry Division, which General Marshall at Fort Bliss in 1942 stated was very likely the best division then in existence because of the high percentage of experienced long term soldiers it contained, was very definitely a division with tradition—regimental rather than division tradition. The 5th, 12th, 7th and 8th regiments of cavalry which made up the division's major units had been units of the Army from over 40 to nearly 90 years. The 5th was organized by Jefferson Davis and had Robert E. Lee and Jeb Stuart as commanders. The 7th was Custer's regiment which was slaughtered with him by the Indians in 1876. At no time in their history have these or any other units of any armed force performed more gallantly than they did during these operations—150 pages illustrated. Government Printing Office, Washington, D. C. Price 40c.

S.H.S.

IRON OUT OF CAVALRY,

by Walter Phelps Hall. Appleton-Century Company Inc. $4.00

Here, in a single compact and readable volume, is the full military, political and social history of the war just ended. It is a clearly written history with a realistic viewpoint.

A Buddy Lost.

LAST CHAPTER,

by Ernie Pyle. 143 pages; illustrated. Henry Holt Co. $2.50

The Jap bullet that took Ernie Pyle's life on Ie Shima cost America—and particularly her fighting men—a great friend and even greater reporter. There would have been no voice raised in dissent had the wording of the memorial sign on the spot where Ernie Pyle was killed—*At This Spot the 77th Infantry Division Lost a Buddy—Ernie Pyle*—been broadened to include the whole American public.

To date, no other writer has been able to approach Pyle's free and easy, yet pungent, words that came straight from his heart, and which were written in the foxholes where the fighting was being done. The only improvement on his written accounts of the war might be to have heard him reminisce in person.

Returning home from Europe in 1945, Ernie Pyle rested briefly, and then took off for new experiences and new hardships and self-sacrifice on the Pacific battlefronts. He went first to the Mariannas and spent some time at the B-29 base there, living with the boys who were dropping the bombs on the Japanese homeland. He then boarded an aircraft carrier for the invasion of Okinawa, where he went ashore with the Marines and covered considerable miles with them before he was killed.

Cut short of completion by his untimely death, *Last Chapter* is not a long book, but it has the punch of human interest and honesty of writing that had become Pyle's trademark. Assuredly, it will join his other books on the list of the really fine reporting jobs to come out of this war.

R.F.C.

Devastations of War.

LOST TREASURES OF EUROPE,

edited by Henry LaFarge, Pantheon Books, 487 illustrations. $5.00

Architecture always suffers more heavily than other art forms during a war of annihilation. Of the material evidences of our civilization, of our roots in the past and our guide to the growth of culture, painting and sculpture, being movable, suffer less than architecture, which must stand the brunt of advancing armies. Where possible in the Second World War the Allies caused much to be spared in Europe through planned bombing. But it was inevitable that pulverizing ground offensives should destroy priceless monuments of beauty, as the grinding offensives in the heavily contested Rapido River and Cassino areas, the East Coast and Apennines in Italy.

Lost Treasures presents only such architecture and art totally destroyed or destroyed beyond repair. It is a comprehensive picture of waste and destruction of interest to everyone who has seen the beauties of Europe or has an interest in them.

France is represented mainly in the devastated Cherbourg-Calais-Rouen triangle. Gone, too, is the once proud Cathedral of Notre-Dame at Saint-Lo.

Italy suffered loss of the Abbey of Monte Cassino, founded in 529 by St. Benedict, which appears today a cellar of rubble. Rome was spared except for San Lorenzo-fuori-le-Mura. At Impruneta the Church of Santa Maria is gone, taking with it the magnificent bas-reliefs done by Luca della Robbia.

Russia lost much, including the great pilgrimage shrine Pechersk Lavra. Germany naturally reaped the harvest. Towns familiar to everyone are grim skeletons: Nuremberg, Wurzberg, Berlin and Munich. At Koln the Dom stares at ruins of medieval architecture dating back to the Hanseatic League. Mainz, the pearl of Renaissance cities, has lost her picturesque market place. Danzig is totally destroyed.

RADAR,

What Radar is and How it Works, by Orrin E. Dunlap, Jr. Harper and Brothers. $2.50

The first popularly written story of radar, dramatically portrayed against the author's extensive background and knowledge of radio. It reads like fiction yet is scientifically accurate and within the understanding of a school boy as well as the radio amateur and the average radio listener who wants to be informed on this vital new advance of science.

WE CAUGHT SPIES,

by John Schwarzwalder. Duell, Sloan and Pearce. $3.00

Major Schwarzwalder has done a capable job in turning out a book that describes the activities of the Army Counter Intelligence Corps. He tells how enemy agents were caught and their plans upset. The book is full of actual cases that give the reader insight into the workings of CIC men.

RADIO TROUBLESHOOTER'S HANDBOOK,

by Alfred A. Ghirardi. 744 pages; illustrated. Murray Hill Books, Inc. $5.00

Never before has such a wide variety of useful servicing information been presented so helpfully and so authoritatively within the covers of a single volume. There are literally scores of time-saving charts, graphs, and tables which give you instant answers to daily problems which otherwise would mean wasted time and effort. This book gives you the common trouble symptoms, their causes and remedies for over 4,800 models of the 202 makes of receivers you are called upon to service every day—all carefully indexed so you can find them in a jiffy. It is a book that can pay for itself on the very first job—then help you make bigger profits and do better work for years to come.

THE ILLUSTRIOUS EMPEROR,

by Hope Danby. Ziff-Davis Publishing Co. $3.00

A romantic, historical novel of ancient China, telling the story of the Emperor Ming Huang and his love for Bracelet of Jade, his concubine, who changed the course of his life and Chinese history. Based on fact and supported by intensive research, *The Illustrious Emperor* is not only excellent reading but a glimpse into the fabulous past of China.

TABLE IN THE WILDERNESS,

by Norton S. Parker. Ziff-Davis Publishing Co. $3.00

An exciting dramatic novel, based on the life of the Biblical Joseph, it is a book not easily put down once begun, and not quickly forgotten when it is finished. There's a great love, a great central figure, and thrilling episodes—all skillfully woven against a vivid historical background.

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SIGNALS IN AAF

Shoran

What is the meaning of the word "Shoran"? Simply this; Shoran is short terminology meaning short range navigation.

What are its applications? Shoran may be applied for several distinct purposes, a few of which are: (1) Geodesy, (2) aid to Navigation, (3) to enable combat aircraft to pin-point their exact position in relation to two ground radar stations, and (4) to drop their payload on the enemy targets without any visual reference to the terrain below.

During the early stages of the allied aerial offensive in World War II, the need for a more precise method of blind bombing became greater and greater, RCA Laboratories assumed this responsibility and sucessfully developed and designed a radar to meet these requirements. The equipment proved to be even more accurate than had at first been expected, hence many bombing missions were accomplished with amazing results through heavy undercasts.

The Shoran method of bombing was first used in the war in the Italian campaign and later in Germany where it enabled accurate bombing through extremely adverse weather conditions. The accuracy with which hits were possible, even with unskilled men, indicated that by modifying the instrument and by developing mathematical methods of computation, far greater accuracy could be obtained.

This has been proven in experiments during the past several months at Buckley Field, Colorado. Modification of the instruments and development of methods of correcting instrumental errors have provided an accuracy undreamed of before. The mathematical investigation even included correction to the distances for the change in velocity of radio waves with varying meteorlogical conditions. All of the mathematical researches conducted today constitute a large volume

Geodesists have long seen the need for a more accurate, cheaper, less time consuming and practical method of surveying and mapping the earth's true surface. At the present time there are still many areas on the surface of the earth which are entirely inaccessible to land surveying parties. Even certain areas which are available, present tremendous hazards such as malaria infested jungles, thick underbrush, wild animals, and in some cases savage tribes of natives. The only answer to the problems now encountered by the Geodesist is the "Shoran Method."

Geodetic surveying on land makes use of mountain tops as reference points for triangulation. Until now, it has been impossible to use it in mapping of islands when they are too far apart to be seen from one another. But a plane can fly high enough to see by Shoran for hundreds of miles over the curvature of the area. Thus, for the first time, huge unmapped areas can be pinpointed to existing charts with an obviously huge benefit to aerial and sea navigation. It will be a great boon to civil and army aviation in the now poorly charted areas of the world. It will also be possible to establish a Geodetic control network of the entire globe, and plot every point from every other point within a few feet. With these control or triangulation stations located, they in turn can be used in aerial map making by accurately determining the position of each aerial photograph taken from a plane in flight.

The Shoran instrument installed in an aircraft sends out short wave pulses to two ground stations which rebroadcast the signals back to the plane. To measure a long distance, a Shoran equipped airplane rises to elevations up to 40,000 feet. The plane fires its electronic bullets at the previously placed Shoran ground stations, which upon intercepting the plane's "key" signal is immediately converted into distances on a dial to thousandth's of a mile. The interval between the departure of the signal and the arrival of the return signal is measured in fractions of one millionth of a second, or "microsecond." The ground station signal is seen on the cathode-ray tube of the plane's Shoran apparatus as the station fires back a burst of radio energy to the plane. Thus, distances greater than 500 miles can be measured extremely accurately without any of the surveying party setting foot on land or even seeing it.

Shoran has many possibilities. It is not at all absurd that an instrument will be developed on the Shoran principle which will enable a plane to be brought home from a distance of several hundred miles to make a completely blind landing under the most adverse weather conditions. It is further predicted that an automatic ship's pilot for an ocean going vessel will be developed based on the Shoran principle which will enable that vessel to navigate through a long and tortuous channel in a dense fog entirely automatically without a helmsman at the wheel provided, of course, that the channel has been previously accurately charted by Shoran. Cooperative Shoran world remapping projects by all important governments of the world will provide the necessary maps and charts which are required to make aerial and sea navigation safer in the future.

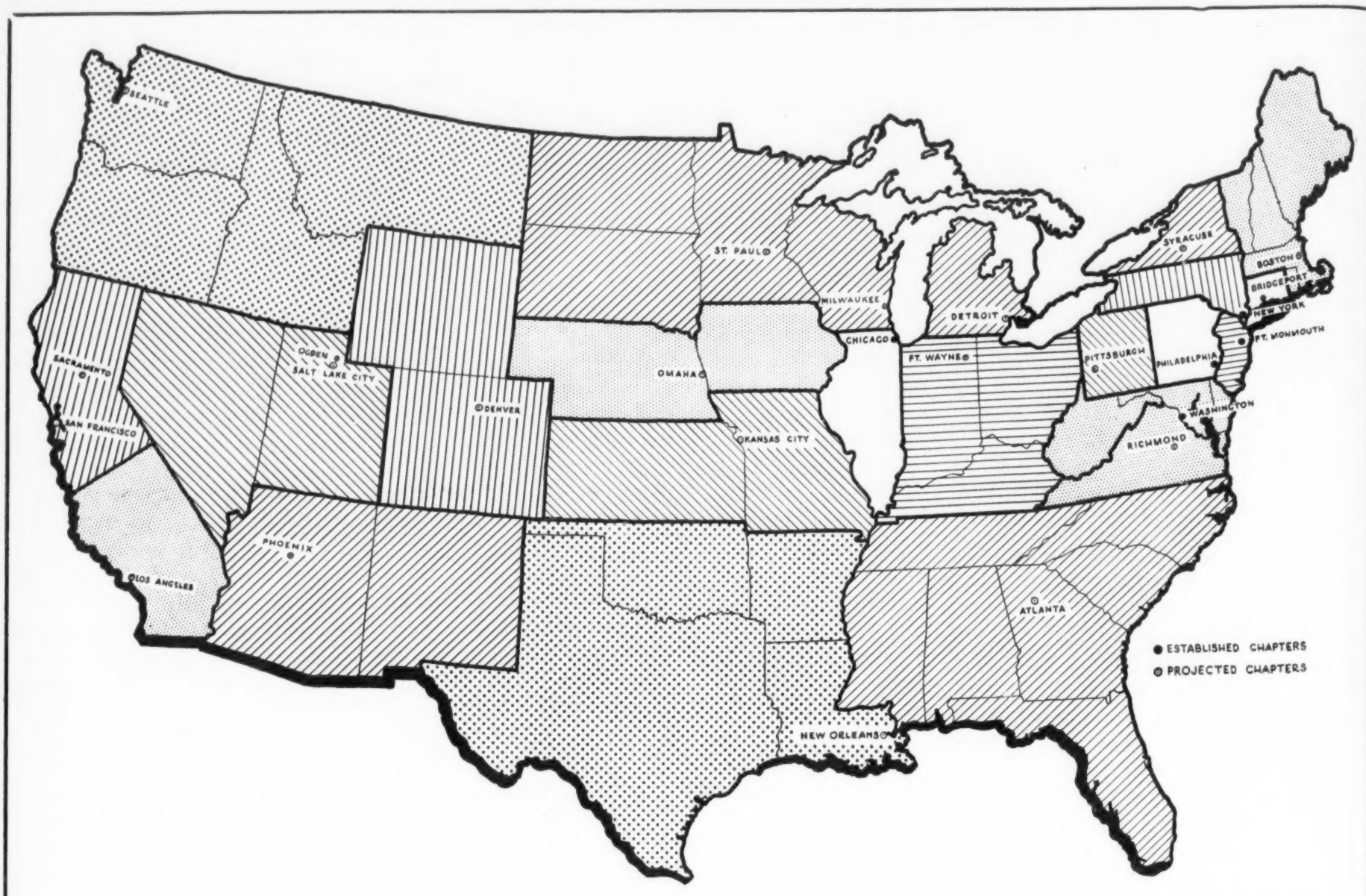
The past War has certainly brought proof of this nation's need for the continuance of research and developments. It has proven by such astounding developments as Shoran that we have the potential power to forever lead the world in the field of research. We have the resources. We must continue to have the backing of the American people if we hope to maintain our national security.

Yale University has established the first Air ROTC unit, which will train ground officers for AAF operations.

Chapter Roundup

WILLIAM J. HALLIGAN

Vice President in Charge of Chapter Formation



Listed below are the cities shown on the map and the names of the local representatives who have been designated to help organize local chapters in their respective areas. We are establishing contacts in those cities that have no local representative indicated.

SEATTLE
Brig. Gen. T. J. Tully

SACRAMENTO
Col. A. M. Shearer

SAN FRANCISCO
Col. W. D. Dillinger

LOS ANGELES
Col. Frank Capra

PHOENIX
Col. Roy T. Richards

OGDEN-SALT LAKE CITY
Lt. Col. Douglas Toft

DENVER
Col. A. W. Young

KANSAS CITY
Ruby D. Garrett

DETROIT

NEW ORLEANS

ATLANTA
Col. Thomas H. Maddocks

OMAHA

ST. PAUL

MILWAUKEE
Col. J. S. Vaughan

CHICAGO
William J. Halligan

FT. WAYNE

RICHMOND

WASHINGTON
Capt. Harry E. Fisher

BALTIMORE

PHILADELPHIA
Col. W. W. Watts

NEW YORK
Lt. Col. David Talley

FORT MONMOUTH
Col. W. L. Seibert

BRIDGEPORT

BOSTON

SYRACUSE

PITTSBURGH

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1st Vice President
William J. Halligan

2nd Vice President
Darryl F. Zanuck (Col.)

3rd Vice President
Fred Friendly (M/Sgt.)

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Thomas Riviere (M/Sgt.)
George P. Dixon (Col.)
J. Harry LaBrum (Col.)
H. W. Hitchcock
Paul Galvin
W. L. Hallahan (Col.)
Leslie F. Muter
William C. Henry (Col.)
Theodore Gary
Frank B. Jewett
Harold A. Zahl (Lt. Col.)
Fred R. Lack
John J. Ott (C.W.O.)
H. A. Ehle
Col. F. W. Wozencraft, Counsel
Brig. Gen. S. H. Sherrill, Exec. Sec'y.

GOAL IS REACHED ASSN. NOW 5000 STRONG

ASA is over the 5,000 mark in memberships! We're going great guns now but just think what could be accomplished with 10,000 members! We've got seven chapters organized and expect to have at least 25 within the next six months. Building memberships nationally and getting chapters formed locally will not only help the Association and the cause of military communications and photography, but *yourself* as well. Here's how:

The individual sponsoring the most new members before next May 1 will receive a cash prize and valuable prizes, which you can select yourself, will be given on a point system to others getting members for us. Details of the contest are still being worked out but we are letting you in on the contest early so you can get a head start. The next issue of SIGNALS will carry the entire plan—watch for it. And here's added incentive. The chapter and the individuals will be spotlighted in SIGNALS when the results of the contest are announced. Get new members and start rolling up points now! Application blanks and information books will be sent upon request.

Join the competition! Put yourself and your chapter on the map. We are out to double the memberships and we need *your* help!

Strength Through Chapters

Check the map which appears on the opposite page and see if there is already a chapter in your area. If there is not and you think there might be a sufficient number of interested persons in your vicinity to support a chapter, write us and we'll help in every possible way to assist you in getting a really live-wire chapter started. If your city is shown as a center for a projected chapter, you will undoubtedly be notified when a general meeting is called. If you would like to help in the organization, let us hear from you and we will put you in touch with the individuals designated to spearhead the drive. Remember that the strength of the Association is going to depend tremendously on the strength of the local chapters.

Election of Officers

The September issue reported that the first general election of officers would be held 30 days after ASA memberships reached the 5,000 mark. However, at a recent Executive Committee meeting it was decided to hold the first convention and election in April or May of 1947 at Fort Monmouth at the same time the first annual demonstration of newly developed communication equipment is scheduled.

THE NEW YORK CHAPTER is number one on the list of ASA chapters. They have been given that honor because it is formed from the nucleus of the old American Signal Corps Association—an organization that worked continuously during the years of general complacency between World Wars I and II, toward the same objectives to which we are subscribing. The Association will benefit greatly by drawing on the experience of this seasoned group. Their first meeting as a local chapter of Army Signal Association was held at old Fraunces Tavern—a favorite place for meeting in past years. The Chief Signal Officer, Maj. Gen. H. C. Ingles addressed the assemblage and Brig. Gen. David Sarnoff, our national President, attended and made a short talk. Brig. Gen. S. H. Sherrill, Executive Secretary, presented the Charter. Col. Frank P. Dixon who has been instrumental in getting the new chapter organized is now in South America but his good work has left its mark on the success of the formation. Interim officers are: Brig. Gen. C. O. Bickelhaupt, President; Col. William L. Hallahan, 1st Vice President; Brig. Gen. Charles E. Saltzman, 2nd Vice President; Lt. Col. Frank H. Fay, Secretary; Lt. Col. David Talley, Treasurer. All members in the New York area who have not been contacted and would like to join the chapter, should notify Colonel Fay whose address is 479 Darlington Ave., Staten Island 12, New York.

FORT MONMOUTH is known as number two chapter of ASA. They got the ball rolling in August and have run up the wonderful score of over 700 members. Plans are now under way to inaugurate a program wherein they can best accomplish their contributing share of aid to the Association as a whole and in strengthening their chapter. Officers are: William L. Seibert, President; Charles DeVore, 1st Vice President; Dorothy M. Lively, 2nd Vice President; Dr. Virgil F. Payne, Secretary; Cedric Flagg, Treasurer; and Ruby M. Knoll, Assistant Treasurer.

CHICAGO, number three chapter, held their initial meeting at a dinner the early part of October. The response was gratifying and enthusiasm is running high in their aim to be one of our strongest chapters. The Chief Signal Officer, Maj. Gen. Harry C. Ingles addressed the group emphasizing the important role that the Association can play in the postwar plans for military preparedness. Mr. S. I. Neiman who is doing such a fine job as publicity agent for the Association, reports that their chapter is launching a plant-by-plant canvass for new ASA members. One of their outstanding members is Mr. Paul V. Galvin who has recently accepted the Chairmanship of the National Advisory Committee on Radio. Officers designated are: William J. Halligan, President; E. W. Shepherd, 1st Vice President; Cyrus T. Read, 2nd Vice President; S. I. Neiman, Secretary; Jerome J. Kahn, Treasurer; and J. F. Novy, Assistant Treasurer. Any individuals living in the Chicago area who have not been notified of the organization of the chapter, should contact Mr. Neiman whose address is One North LaSalle Street.

THE PHILADELPHIA CHAPTER. The response to the initial meeting of our number four chapter was so much greater than had been anticipated that only 300 of the 600 that came could be accommodated. Although it was regretted that so many had to be disappointed, the dinner which was held on October 8th was highly successful and plans for the actual organization of the chapter were discussed. Col. W. W. Watts of RCA in Camden, organized the dinner and served as Master of Ceremonies. The Chief Signal Officer, Maj. Gen. H. C. Ingles made the principal address and other speakers were Brig. Gen. S. H. Sherrill, Executive Secretary of ASA, Mr. H. A. Ehle, ASA Director, and Col. J. Harry LaBrum who is also a Director of the Association and is in charge of chapter formations throughout the 2nd Army Area. The officers of the Philadelphia Chapter have not yet been designated.

THE WASHINGTON CHAPTER members assembled for their first luncheon meeting on November 7th to discuss future activities. Over 100 were in attendance to see the exceptionally fine Signal Corps motion picture "Pro Patria Vigilans," dealing with old and new methods of military communication preparedness and to hear a splendid address from the Chief Signal Officer. Other speakers included Brig. Gen. S. H. Sherrill who presented the Charter, and Mr. J. B. Morrison of the Chesapeake & Potomac Telephone Company. Captain Harry E. Fisher who has worked tirelessly in getting the Washington Chapter organized was in charge of all arrangements. Mr. Thomas Riviere, a Director of ASA, is very active in the Chapter and has brought in many new members. Interim officers are J. B. Morrison, President; Roger B. Colton, Walter K. Scott and Lynnwood Gentry, Vice Presidents; Harry E. Fisher, Secretary; and Conrad E. Snow, Treasurer.

THE MID-PACIFIC CHAPTER is being formed as our number one overseas chapter. They proudly sent their petition to National Headquarters early in September on their own specially designed letterhead which was decorated with the crossed flags. Colonel M. E. Gillette has done much to arouse general interest in activating this chapter in Honolulu. Full particulars concerning their proposed activities have not yet been received. However, a full account will be carried in the next issue of SIGNALS.

THE ALASKAN CHAPTER is another evidence of growing interest in ASA outside the States. Their petition has been received and all reports indicate that the men of that area are very enthusiastic about plans to have a fine chapter. Col. Byron A. Falk and Captain Howell J. Parry are among the many who have contributed much toward making a success of the organization.

OKLAHOMA A&M is the first of the college R.O.T.C. Signal units to take steps toward forming a student chapter. We hope that they will set a precedent for many more such units to organize. ASA now has over 200 student members.

More than 120 members attend first meeting of Washington Chapter, ASA, at the Roger Smith Hotel. General Ingles was the featured speaker.

SIGNAL CORPS NEWS

FROM THE CHIEF SIGNAL OFFICER

PROCUREMENT

AT THE end of World War II Signal Corps procurement was drastically reduced, the demand for a majority of the items no longer existing. However, the procurement of certain materiel has been continued at a reduced scale: namely, items of an expendable nature and those developed late in the war with which the troops were not completely equipped and which were notably superior to equipment used in the field.

Radio Set AN/GRC-9, a low powered set which is designed to provide medium range communication between ground force units, is an outstanding example of a superior equipment which is being furnished the Army. Procurement of this set was continued since it provides a more reliable channel of communication than that now provided by the SCR-694 and it is considered essential for troops engaged in occupational duties as well as for large scale training maneuvers.

The effectiveness of the postwar Army will depend in a large part on the strength of its reserve units, notably the National Guard, Reserve Officers Training Corps and Organized Reserve Corps. To facilitate the training of these groups, 16mm sound motion picture Projectors PH-131 are being obtained. These will permit the civilian components of the Army to use the training film found so essential during the war. A large number of Reproducing Equipment MC-364 are also being provided so 35mm film strips can be utilized.

During combat, many GI's wearied of the almost endless task of unreeling and laying wire. To partially alleviate this headache, the Signal Corps is continuing repackaging Assault Wire W-130 into an expendable container, Wire Dispenser MX-306/G. The dispenser is a light carton in which the wire is coiled much as twine is rolled in a ball. The wire can then be pulled from the center of the coil at high speeds, permitting it to be laid from a moving vehicle or low flying airplane.

Another example of the effects of improvements in communication equipment on Army operation is the establishment of facsimile nets to transmit weather maps for general use. In the past, basic weather data was sent by teletype to various weather stations, which then prepared weather maps for analysis by skilled observers. Under the new plan, maps can be immediately exchanged by the forecast stations. Airfields and other users of such data can immediately obtain copies of these maps without requiring the services of observers to prepare the map and without the normal delay of dispatch by mail or messenger. Facsimile Equipment AN/TXC-1 and its associated Converter CV-2/TX are the major items being procured to permit the implementation of this network.

In obtaining basic data used for meteorological purposes, another Signal Corps development, Radiosonde AN/AMT-2, plays a vital role. Production of this unit is therefore being continued. This lightweight equipment, carried aloft by a hydrogen-filled balloon and tracked by Radio Set SCR-658, not only provides data on barometric pressure, temperature and humidity as the instrument is carried aloft, but it also enables the ground observer to accurately determine the direction and velocity of the wind up to 60,000 ft. by RDF methods.

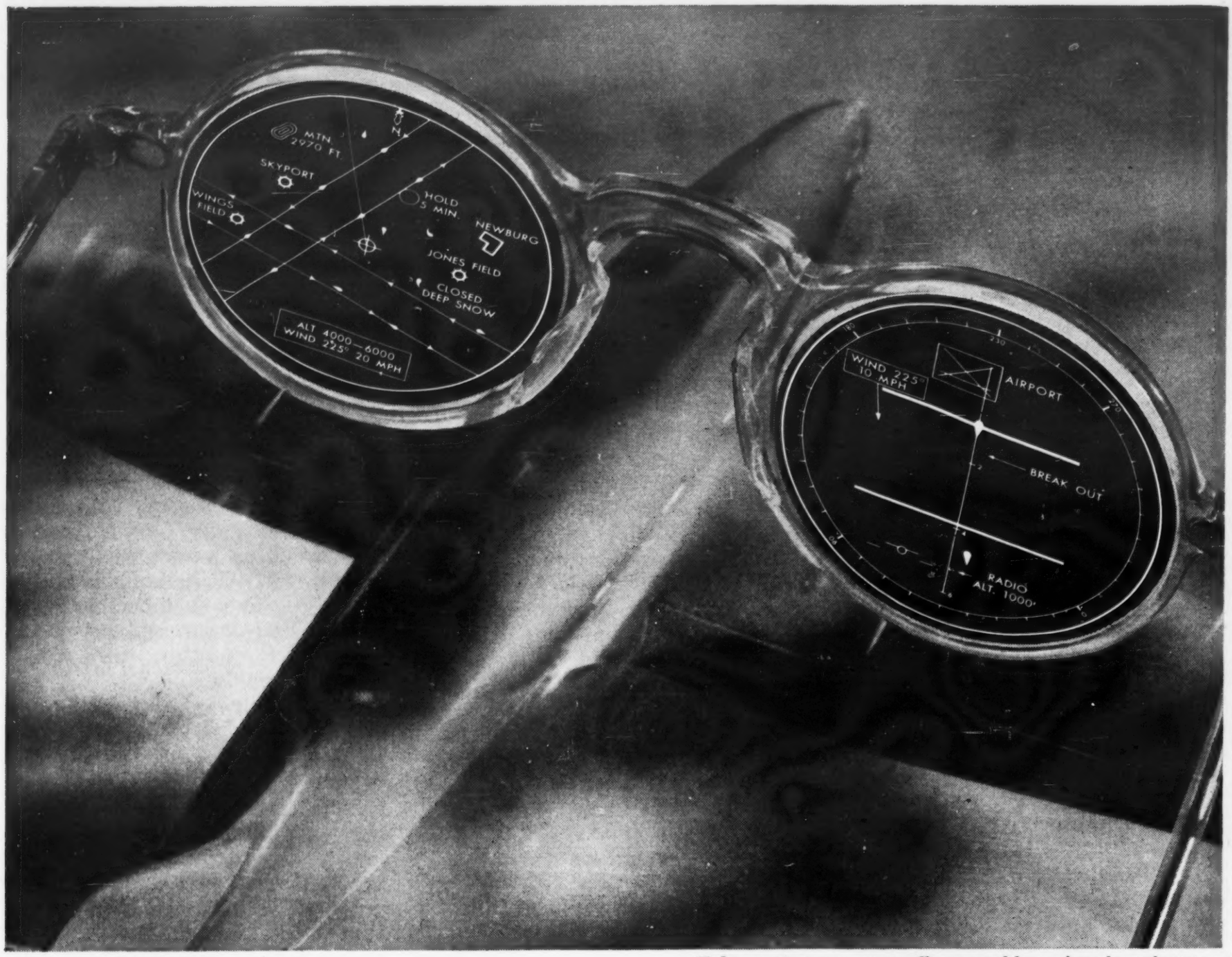
As stressed by the Chief Signal Officer in the initial issue of SIGNALS, the Signal Corps has played a paramount role in the introduction of radar in its present form. To keep pace with the latest developments in this field, procurement is currently under way for Conversion Kits to modify Signal Corps radar Radio Set SCR-584, for improved operation in the range and accuracy of this micro-wave equipment.

An item soon to be procured for use with radar equipment will be Motor Generator Set PU-20( )/C, a generator which will furnish the 400 cycle current required by many lightweight radar sets. This item is to be used in powering airborne radar Radio Set AN/APQ-13 when installed in ground locations for fixing and tracking thunderstorms. This airborne radar equipment is undoubtedly well known for its valiant work in the high level bombardment of Europe and Japan and its use in weather forecasting may be a distinct surprise.

In order to maintain and operate existing signal equipment, a large percentage of the present Signal budget necessarily goes for the procurement of expendable supplies, such as vacuum tubes, dry batteries and miscellaneous repair parts. Particular emphasis is now being placed on the production of cold-weather type batteries since the war demonstrated the extremely short life of dry batteries during winter operation.

Future procurement of signal equipment is, of course, dependent upon budget limitations set by Congress. At present, it is being restricted to items which are essential for the continued operation of the Army.

The Philadelphia Signal Depot is to be transferred to the facility known as Martin Bomber Plant No. 2 at Middle River, Md., by next March 31. The Maryland plant has been withdrawn from surplus and assigned to the Chief Signal Officer. To remain in Philadelphia would necessitate leasing 50% commercial space for continued operations on a long-range basis. Therefore, as an economy measure all installations and activities except salvage, surplus property, and property to be declared surplus will be moved.



Teleran pictures—air traffic control by radar plus television.

Teleran—"radio eyes" for blind flying!

It's a television "information please" between airplane and airport—with the pilot's questions given split-second answers on a television screen mounted in the cockpit.

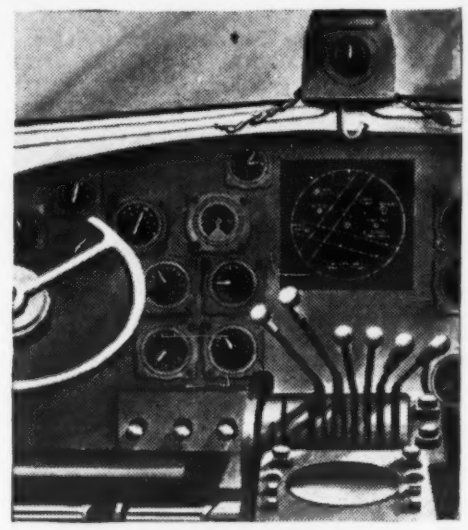
Teleran (a contraction of *TELE*vision—*R*adar *A*ir *N*avigation) collects all of the necessary information on the ground by radar, and then instantly transmits a television picture of the assembled data to the pilot aloft in the airplane.

On his receiver the pilot sees a picture showing the position of his airplane and the position of all other aircraft near his altitude, superimposed upon a terrain map complete with route markings, weather conditions and unmistakable visual instructions. The complex problem of air traffic control is well handled by Teleran.

Teleran—another achievement of RCA—is being developed with Army Air Forces co-operation by RCA Laboratories and RCA Victor, endless sources of history-making developments in radio and electronics. They are also your assurance that *any* product bearing the RCA or RCA Victor monogram, is one of the finest instruments of its kind science has yet achieved.

• • •

Radio Corporation of America, RCA Building, Radio City, New York 20 . . . Listen to The RCA Victor Show, Sundays, 2:00 P.M., Eastern Standard Time, over the NBC Network.



Instrument Panel of the Future. The Teleran indicator, mounted in a cockpit, simplifies the pilot's job by showing his position relative to the airport and to other planes in the vicinity. It promises to become one of the most useful developments in the history of aviation.

RCA **RADIO CORPORATION of AMERICA**

Recent Signal Developments

This column will present short descriptions of newly-developed signal equipment which has not been produced or used in quantity. The information should be of interest not only to Signal Corps personnel, but to our Group Members as an indication of the type of equipment which would be needed, in case of an emergency, to replace similar items used during the recent war.

Wire WD-1/TT

Wire WD-1/TT is the most important field wire to result from the wartime research and development program. The ideal field wire is one which possesses the minimum possible size and weight consistent with the required talking range, tensile strength and durability. Wire WD-1/TT represents the nearest approach to the ideal yet attained.

This wire was developed to serve as a general purpose communication wire for use by troops in forward areas, normally from regimental headquarters forward. It is a twisted pair, field telephone wire, each conductor of which consists of four copper and three steel strands, each 0.011 inch in diameter. Each stranded conductor is separately insulated with a polyethylene compound and covered with an extruded nylon jacket. The wire weighs 47 pounds per twisted-pair mile and has a minimum breaking strength of 85 pounds per single conductor. The voice frequency talking range of Wire WD-1/TT between two Telephones EE-8-( ) is 11 miles wet and 18 miles dry.

This wire is sufficiently flexible and light in weight for use as an assault wire, has a transmission range fully as great as that of the standard field Wire W-110-B, and is only slightly less durable. The polyethylene insulation gives Wire WD-1/TT its excellent electrical characteristics, while the tough nylon jacket accounts for its durability.

Wire WD-1/TT is issued in ½ mile lengths in Wire Dispensers MX-306( )/G.

Wire Dispenser MX-306/G

Development has been completed on Wire Dispenser MX-306/G which is now the standard method of packaging assault wire. Each dispenser contains ½ mile of Wire WD-1/TT wound in a solenoidal form to facilitate dispensing the wire at various speeds such as from a manpack, a moving vehicle or a liaison type aircraft without the use of rotating reel equipment. The dispenser is formed by winding the ½ mile of wire on a suitable form by means of a special machine. While the winding is in progress, the wire is given a 360° pretwist for each revolution of the coil form and is given an application of a light glue. The pretwist prevents the wire from kinking when drawn from the dispenser and the glue prevents the wire from running too freely and the layers from collapsing when the wire is being payed out. The coil is then encased in an expendable metal container. The finished dispenser is 6 inches long, 14 inches in diameter and weighs approximately 33 pounds. Continuous communication is possible over the wire during the payout operation. Three "D" rings spaced at 90° intervals around the periphery facilitate lashing the dispenser to a standard Quartermaster packboard, and the increased ratio of diameter to length of Wire Dispenser MX-306/G in comparison to earlier types permits it to be carried on the soldier's back with greater comfort. Two or more dispensers may be prespliced in tandem prior to the starting of the wire laying operation if desirable. Some of the special applications of Wire Dispenser MX-306/G include laying wire from a liaison type aircraft, and over relatively short distances by means of rockets or rifle grenades, thus enabling wire communication circuits to be established over inaccessible terrain.

There is also under development a wire pack which is intended to provide an efficient and speedy means of laying lightweight field wire such as Wire WD-1/TT by utilizing a light, canvas covered coil of wire that can be carried conveniently and operated silently and efficiently by an infantryman with full complement of weapons and fighting pack. The wire pack will contain approximately ¼ mile of Wire WD-1/TT, will be about 10″ long and 6″ in diameter and will weigh not more than 12 pounds.

Telephone TP-9-( )

Telephone TP-9-( ) has been developed in response to a long standing need for a telephone capable of providing a longer range of communication than that obtainable with ordinary local battery sets. It is a compact, immersion proof, push-to-talk instrument which will be used primarily on long loops radiating from switchboards and on long point-to-point tactical wire circuits where it is not feasible to install and maintain repeaters.

Both transmitting and receiving amplifiers are incorporated in this telephone, providing a fixed transmitting amplification of approximately 23 db and a variable receiving gain up to 60 db. A switch is provided which cuts out these amplifiers and converts the TP-9-( ) to an equivalent local battery set. The equipment provides a satisfactory ringing signal on all circuits up to and including the maximum length of field wire over which satisfactory non-repeatered telephone communication is possible, and is equipped with Ringer MC-131 to give an audible signal and a non-positional drop to give a silent signal. The over-all dimensions of the telephone are 12½″ long by 10¾″ high by 7¾″ wide, and the weight is 25 pounds, complete with batteries.

Development on the TP-9-( ) was completed on 21 August 1945. It is a standard, unclassified item.

Group Members

Since the last issue of SIGNALS, the following firms have joined the ever increasing list of group members of ASA:

Electronic Associates, Inc.
Tung-Sol Lamp Works
Cornell-Dubilier Electric Corp.
Porto Rico Telephone Co.
United States Rubber Co.
Hugh H. Eby, Inc.
California Water & Telephone Co.
West Coast Telephone Co.
Electric Storage Battery Co.

NOTES FROM FORT MONMOUTH

Last OCS Graduates

With the graduation of the fifty-fifth class, Officer Candidate School came to an end at Fort Monmouth. Maj. Gen. Harry C. Ingles, Chief Signal Officer addressed the 22 successful candidates of the last class. Col. Hugh Mitchell, Deputy Commander of Training, received the famous colors of Signal Corps Officers' Candidate School, from Col. Allen L. Stowell, Assistant Commandant of OCS. During the existence of OCS at Monmouth, over 21,000 young soldiers earned their gold bars. The first class was begun in June 1941 and the school reached its peak in the ninth graduating class in 1942 which commissioned 1,710 new officers. Future candidates will receive training at Fort Benning, Ga.

EM School

The student strength of Enlisted Men's School at Monmouth has been "temporarily" reduced by approximately 3,600. This huge reduction brings the number of students from approximately 6,000 to about 2,400. This step has been taken in conformity with an Army wide move to make available for immediate over-seas replacements and release of those eligible to fill many jobs in this country. Enlisted men with less than 10 months to serve after they would have completed their course of study were the ones dropped. Men with 10 or more months more Army service due were to be shipped overseas and those with less than 9 months to serve would be assigned in this country. Efforts are being made to put the school on a single-shift day. It is believed possible to accomplish this except for the Common Division which will receive the largest number of incoming students. It has not been determined whether or not the school will be further reduced. It should become possible to reduce the number of instructors required by the school and it is planned to discontinue the use of students who have been detailed as instructors.

The Off-Duty Diversion Program recently set up at Fort Monmouth offers military personnel a constructive way to use their off-duty time, permits the continuance of a hobby, and in addition helps in the development of new skills in various fields.

Several buildings have been transformed from barracks to classrooms, and capable instructors are on hand to teach a variety of subjects.

Tools and machines of all descriptions have been provided at no cost to the soldiers. There are woodworking and metal shops, photographic studios, a plastic section, arts and crafts workrooms, radio and camera repair shops.

In the photo shop, for instance, a soldier is taught how to develop his own pictures. A special studio, fully equipped with the latest type of lighting, has been set up for studio work. There are enlargers, developing tanks, trays, chemicals, cameras, and dark rooms. In the plastic section a soldier can learn to make many useful items. At present jewelry seems to be the most popular of the plastic handcraft, although cigarette cases and lighters can always be seen taking shape.

Keeping in mind our real job of training soldiers to be communications technicians, an extensive radio section has been made available. Students in the Signal Corps School, who spend their leisure hours in this modern radio laboratory, are bound to give a good academic account of themselves. These radio men have a language all their own and it's safe to say they like nothing better than to get together with the generators, resisters, coils, condensors, oscilloscopes, and all those other strange items that are available to give radio men many pleasant hours.

Would-be machinists turn up regularly in their off-duty time to operate power drills, drill presses, shapers and lathes. Some of the men have had previous machine shop experience and can already read blueprints or machine a piece of cold roll steel to the desired tolerance.

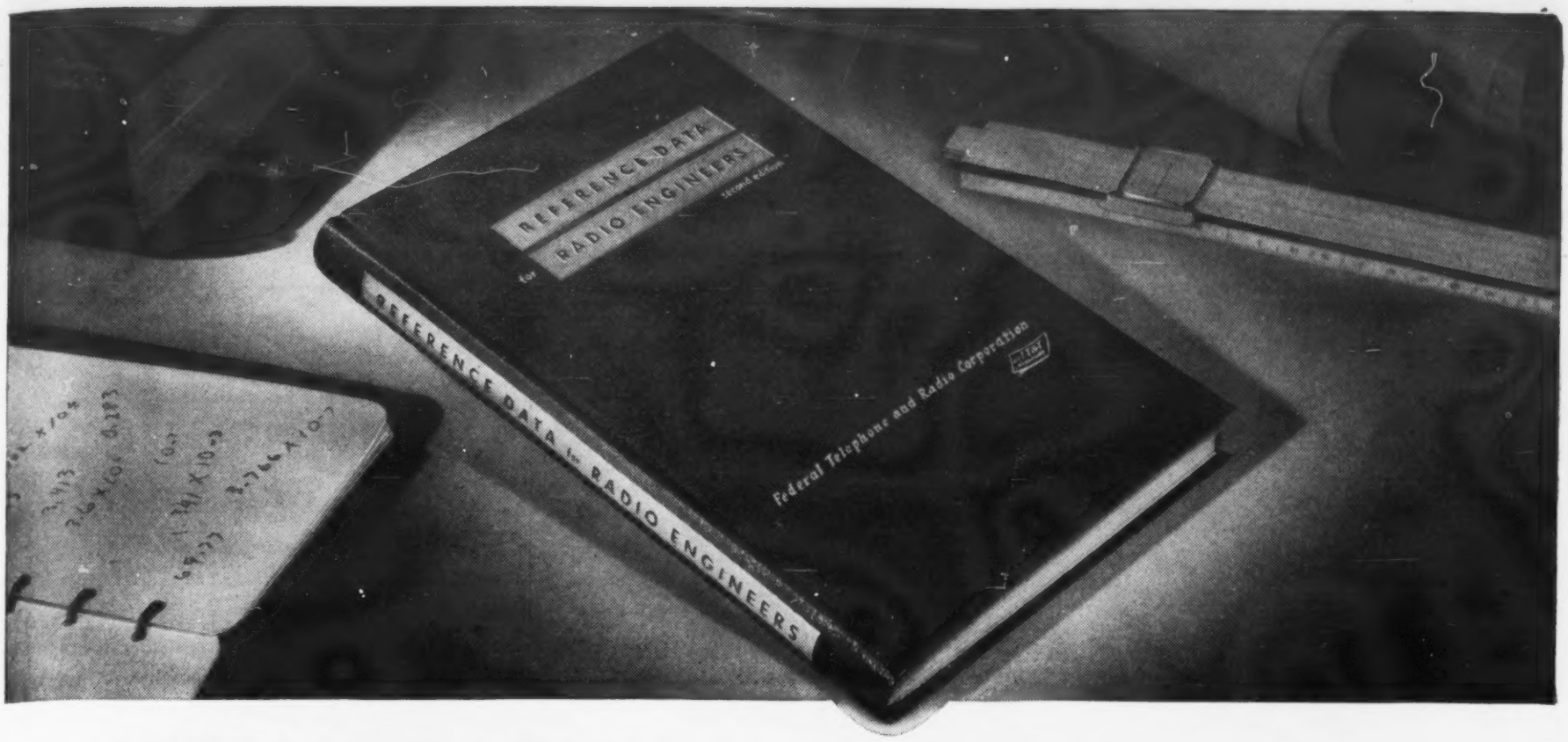
The sheet metal shop has all the tools and sheet steel required to turn out anything from a lunchbox to a penny bank. In all cases, workrooms, material, tools and instructors are furnished by the post; the soldier is required to have the interest only.

The progress shown by many of the men has been excellent. As they learn and become more adept in their selected off-duty subjects, it is planned to exhibit their work in towns and cities adjacent to Fort Monmouth.

The servicemen and women are encouraged by the Commanding General, Brig. Gen. Jerry V. Matejka, and all officers within this command to take part and use the facilities available. The response has been gratifying, and when it is considered that many soldiers might never have known what a lathe or drill press looked like, the Off-Duty Diversion Program becomes increasingly appreciated by those who use its facilities as well as those whose vision turned the idea into a model program.

A brave hero left Fort Monmouth in late October on his way to England where he was to receive the Dickin Medal for gallantry from the Lord Mayor of London. He is "GI Joe," one of the most heroic carrier pigeons to come out of World War II. During the war he was on duty with the British Tenth Corps Headquarters. GI Joe once flew twenty miles in twenty minutes to deliver his capsule thus canceling a British bombing flight scheduled to bomb an objective that had in the meantime been captured by other British forces. This message probably saved 1,000 British lives.

UMI



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Enlarged from 200 to 336 pages with over 400 charts and diagrams, it makes available quickly the answers to problems that normally arise in practical radio work. This ready reference feature is one reason why *Reference Data for Radio Engineers,* in its earlier edition, received such an enthusiastic welcome by electronic specialists. Orders totaled more than 50,000 copies. With the wealth of new material now included, the second edition can be of even greater aid to the practicing radio engineer.

Commenting on the first edition, Walter J. Seeley, Chairman, Department of Electrical Engineering, Duke University, wrote enthusiastically:

> ***"It is so chock full of useful data that I am urging all students to purchase their own personal copies . . . fills a long-felt need for a convenient compilation of both mathematical and engineering data, and the combination will be appreciated by all who have to work with radio circuits and their concomitant mathematics. That applies especially to teachers and students and I should not be surprised if it becomes a must in many college courses."***

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Engineering and Material Data. Wire Tables, Insulating Materials, Plastics: Trade Names, Wind Velocities and Pressure, Temperature Chart of Heated Metals, Physical Constants of Various Alloys and Metals, Thermocouples, Melting Points of Solder, Spark Gap Voltages, Head of Water in Feet, Approximate Discharge Rate, Materials and Finishes for Tropical, Marine Use, Torque and Horsepower.

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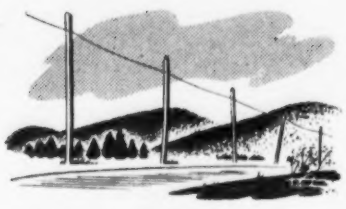
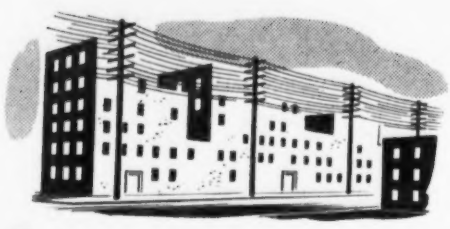
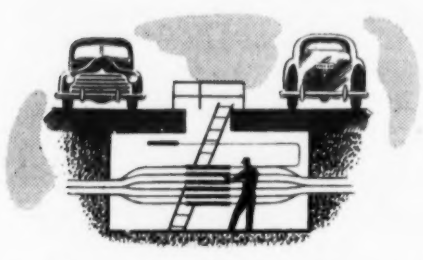


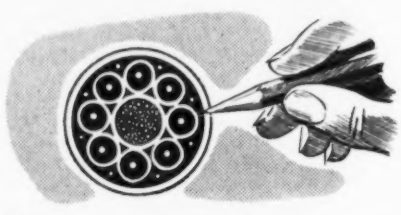
1. *First voice circuits were single iron wires with ground return. Frequency limitations, noise and high losses soon ruled them out.*



2. *Big improvement was the all wire circuit — a pair of wires to a message. Later came carrier which stepped up frequency and permitted several messages per circuit.*

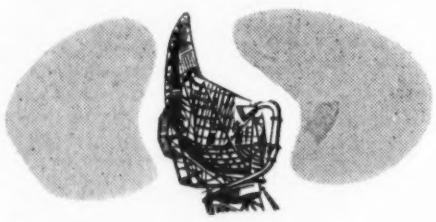


3. *Lead covered cable compressed many wire circuits into small space — took wires off city streets. But losses are prohibitive at very high frequencies.*



4. *Coaxial cable — a single wire strung in a pencil size tube — extended the usable frequency band up to millions of cycles per second and today carries hundreds of messages per circuit, or the wide bands needed for television.*

5. *Wave guides, fundamentally different in transmission principle, channel energy as radio waves through pipes; vary in size from several inches to under 1 cm.; become smaller as frequency rises.*



6. *Late model radar wave guides, similar to that used to feed the antenna above, can carry 3½ cm. waves at more than eight billion cps. Experimental guides for still shorter waves are being tested.*

Back in 1933, Bell scientists established an historic first when they transmitted very high frequency radio waves for hundreds of feet along hollow pipes called wave guides. For them it was another forward step in their long research to make communication circuits carry higher frequencies, broader bands and more messages per circuit.

Continuing Research showed the way

From the days of the single open wire line—through all-metallic circuits, phantoming, cable, carrier systems and coaxials—up to today's wave guides, every improvement has been the result of continuous fundamental study.

When Bell Laboratories started work on wave guides, there was no immediate application for the microwaves they guided. But the scientists foresaw that *some day* wave guides would be needed—so they kept on working until they had developed the wave guide into a practical device.

With the war came radar—and the problem of conducting microwave frequencies. Bell Laboratories had the answer—wave guides—without which radar at the higher frequencies would have been impractical.

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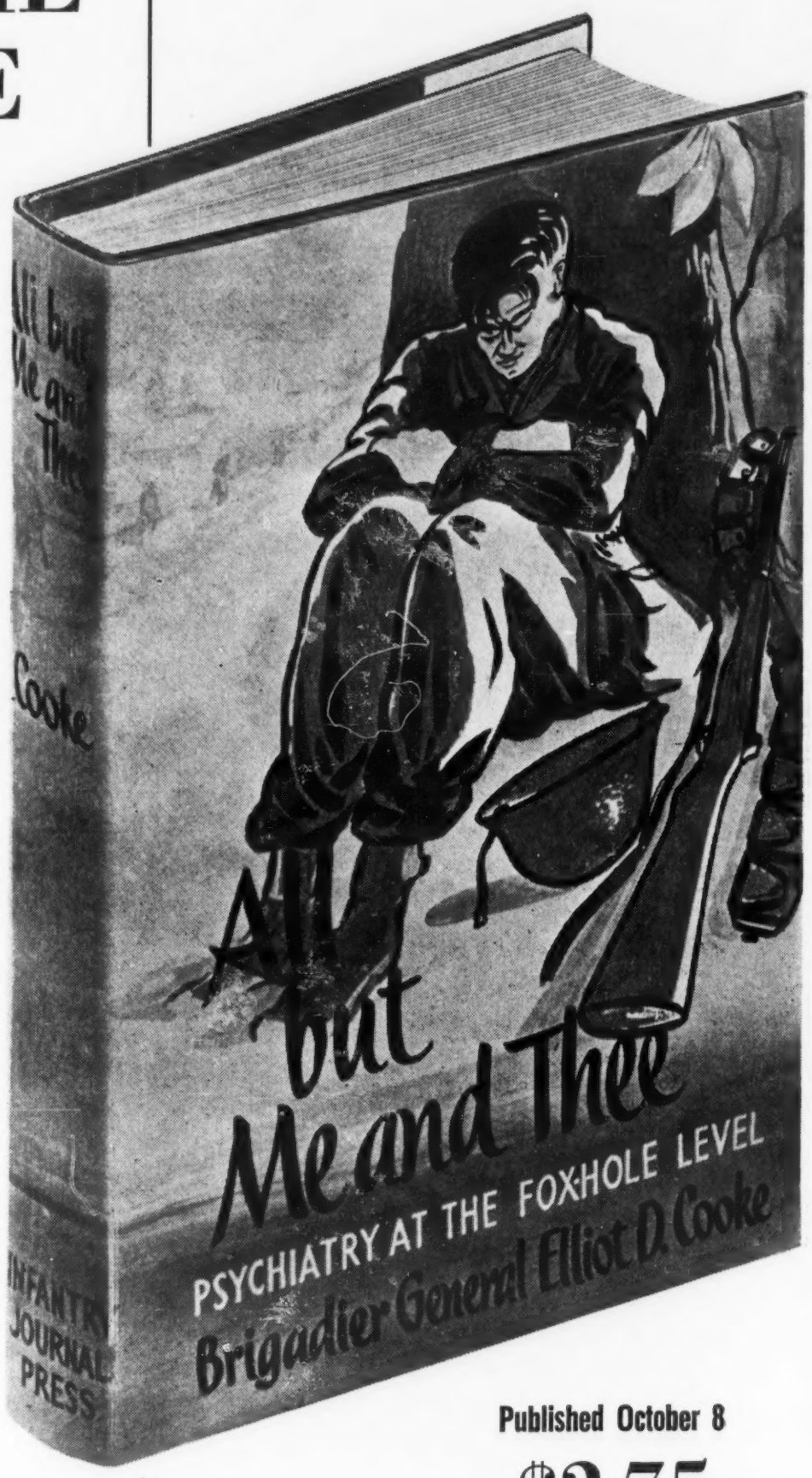

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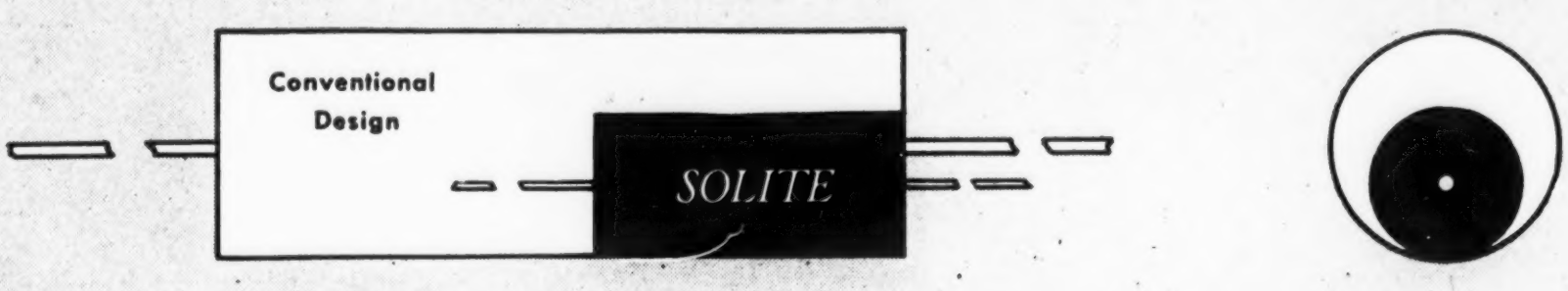

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(mf)		Length	Diam.	Length	Diam.	SOLITE	Conv. Design†
0.1	200	5/8	3/8	1 5/8	1/2	0.08	0.32
0.5	200	1 1/8	15/32	2	11/16	0.13	0.75
1.0	200	1 1/8	17/32	2 1/2	13/16	0.26	1.15
1.0	400	2 1/8	11/16	2 1/2	1	0.69	1.75

† Based on aluminum foil construction. Lead foil capacitors will be still heavier.

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